Boston Region MPO Congestion Management Process

Performance-Based Planning for Efficiency, Mobility, and Safety

BOSTON REGION MPO
CONGESTION MANAGEMENT PROCESS

Performance-Based Planning
for Efficiency, Mobility, and Safety

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Central Transportation Planning Staff

Directed by the **Boston Region Metropolitan Planning Organization.** The MPO is composed of state and regional agencies and authorities, and local government

Introduction

FEDERAL REQUIREMENTS

Metropolitan areas with populations over 200,000—known as transportation management areas (TMAs)—since 1991 have been required by the federal government to have an ongoing Congestion Management Process (CMP). In TMAs that are designated as ozone or carbon monoxide nonattainment areas, transportation projects that add significant single-occupant-vehicle carrying capacity cannot be programmed for federal funding unless the need for the project is analyzed and demonstrated by the CMP. Since the EPA has designated the Boston region as a nonattainment area for ozone, the CMP is especially significant for the future of transportation in the region.[1]

THE BOSTON REGION MPO'S CONGESTION MANAGEMENT PROCESS

The Boston Region MPO has funded a Congestion Management Process (CMP) under various names. Initially the Boston Region MPO called it the Congestion Management System (CMS), a term used by the federal legislation, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Then for several years the MPO referred to it as the Mobility Monitoring System (MMS). Since March 2009, based on the name convention used in SAFETEA-LU and more recently MAP-21(the current federal surface transportation legislation), the MPO has referred to it as the Congestion Management Process. Over the years, additional facilities and services have been included in the monitoring process, and methods for the collection and analysis of data have been improved. In addition, since 1995, this process has become increasingly integrated with the MPO's planning processes and has become more Web-based.

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1 Environmental Protection Agency, "Currently Designated Nonattainment Areas for All Criteria Pollutants as of April 21, 2011," available online at http://www.epa.gov/oaqps001/greenbk/ancl3.html (accessed June 14, 2011).

The CMP is an ongoing program. Its purpose is to develop strategies for the management of congestion based on data acquired through system performance monitoring, and to move those strategies into the implementation stage by providing decision makers in the region with information on and recommendations for the improvement of transportation system performance. The recommendations of the CMP have an impact on the MPO's Long-Range Transportation Plan (LRTP), the Unified Planning Work Program (UPWP), and the Transportation Improvement Program (TIP).

SOURCES OF CONGESTION

Congestion occurs when a transportation facility or service (for example, a roadway segment, intersection, interchange, or transit vehicle) experiences a demand in terms of vehicles or transit passengers that exceeds the space available. This results in problems such as a reduction in roadway capacity, travel speed, bus seats, standing space on buses or trains, and bicycle racks or parking spaces for motor vehicles at rapid transit or commuter rail parking lots. However, in transportation planning, the term "congestion" typically refers to roadways and is the result of a variety of causes, usually grouped in the following four categories:

- Bottlenecks that occur at intersections, interchanges, and other locations where processing capacity is reduced due to traffic signals; to traffic merging, diverging, or weaving across lanes; or to special events, such as sporting events, festivals, conventions, and concerts
- Weather events, such as snow storms
- Temporary capacity-reducing roadway conditions, such as work zones
- Crashes and other incidents that either partially block roadways or cause passing motorists to slow down

The national distribution of these causes, as reported by the FHWA, is shown in Figure INT-1. Nationally, 60% of all congestion is nonrecurring; it is caused by traffic incidents, bad weather, work zones, poor signal timing, and special events. The remaining 40% of congestion is recurring congestion, and is usually caused by bottlenecks.

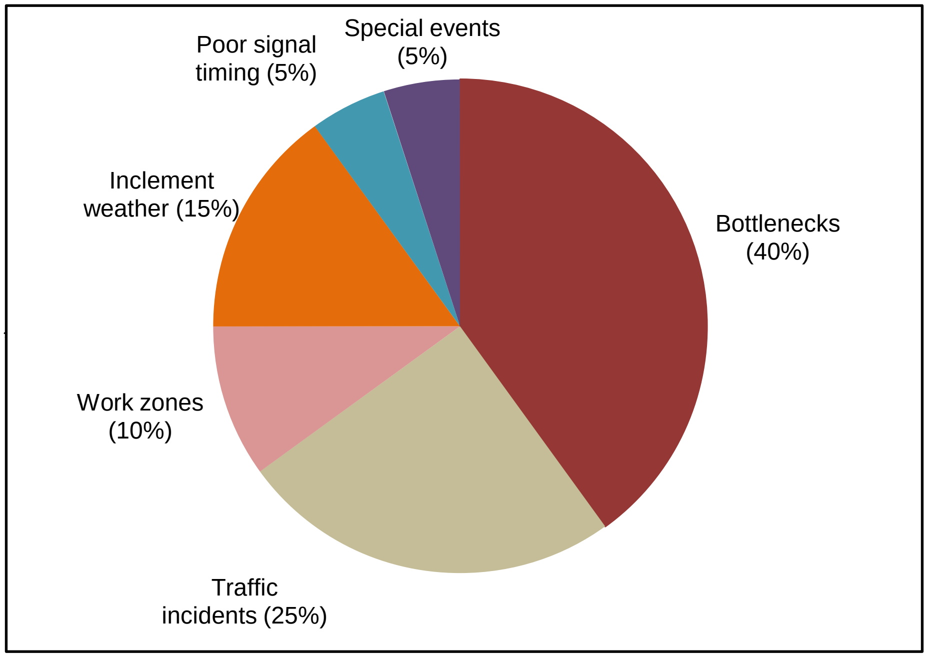

FIGURE INT-1: Distribution of the Sources of Congestion[2]

Although it is not clear how the Boston region congestion pattern compares to the national pattern, it is useful to note several specific features that influence congestion management and the quantity and duration of congestion in this region:

- Boston has a higher density of destinations and population than most U.S. central cities, increasing the potential for congestion from roadway traffic approaching the center, although it also has a rich transit system that serves that area. In addition to radial travel toward Boston, the region experiences significant travel towards satellite high-employment centers, resulting in circumferential travel and reverse-commuting patterns, mostly done by automobile.
- The region is home to several large event venues, such as stadiums, that generate considerable traffic.
- The region is home to many tourist attractions, generating considerable visitor traffic in the public transit system and the pedestrian network, as well as on roadways.
- This region is a mature urban area, where many roadways follow patterns and designs that were laid out prior to the era of automobile use and in a time of much

[2] Source: Federal Highway Administration, http://www.fhwa.dot.gov/congestion/describing_problem.htm (accessed January 16, 2012).

lower population density, making infrastructure changes impossible in many locations.

- Natural barriers in the region (for example, rivers, coastline, and some hills) present challenges to mobility.
- Snow and ice have a significant influence on the region's roadways during the winter months.

However, the Boston region also has some strengths that present unique opportunities for the management of congestion:

- The region has an extensive and well-used public transit network, consisting of rapid transit, commuter rail, bus lines, and commuter ferries to transit stations.
- The region's municipalities have a growing interest in bicycle accommodation, including lanes, multi-use paths, and streets that are retrofitted with bicycle lanes and "share the road" markings.
- The pedestrian-friendly old-city urban design, transit availability, and the high population and employment density of dense urban areas such as Boston, Cambridge, and Brookline make the urban core of the region very walkable at all times of the day.

COMPARING THE BOSTON REGION TO OTHER REGIONS

Boston is one of the older major cities in the United States, located along the Atlantic Ocean. The Boston region is also at the northern end of the Northeast Corridor, which extends southwest to Washington, D.C. The Northeast Corridor goes through several large, dense metropolitan areas along the East Coast that are connected by intercity rail and bus transit. According to the 2010 U.S. census, the total population for this region is over 44 million people. For a better understanding of congestion management issues in a broader context, it is useful to compare the Boston region to other large metropolitan regions in the United States.

Boston has characteristics similar to those of other East Coast cities. The Urban Core subregion is very dense, and many residents in this part of the region rely less on single-occupancy-vehicle travel than residents of other parts of the MPO region, due to the availability of convenient public transportation service. The Boston region also consists of some dense suburbs (inside of I-95). Further out, the Boston region has newer suburbs, which rely more on single-occupancy-vehicle commutes because of the lower densities these areas typically have. More commuters in those areas have circumferential work trips, which are often only feasible by automobile.

Roadway Congestion

INRIX, a company that provides traffic information, travel services, and applications and tools for traffic management, also periodically develops a National Traffic Scorecard.[3] The current ScoreCard, published in April 2012, ranked the Boston region as having the tenth-highest roadway congestion in the nation over the previous 12 months. This ranking is slightly higher than Miami's (12.8) and slightly lower than Chicago's (13.3). Boston has a lower INRIX index than many other Northeastern urban areas, such as New York, Bridgeport, and Washington, D.C., but has a higher INRIX index than Philadelphia, Baltimore, and Providence.

According to the Texas Transportation Institute's 2010 Urban Mobility Report, in terms of the total number of hours of travel delay experienced by auto commuters, the Boston region was ranked tenth in the nation (119 million hours in 2009)—worse than the Atlanta region (112 million hours) and better than the San Francisco-Oakland region (121 million hours).[4]

In terms of the total number of hours of truck delay, the Boston region was ranked twelfth in the nation (6.2 million hours in 2009). This is better than the San Francisco–Oakland region (6.8 million hours) and slightly worse than the Seattle region (6.2 million hours).

Public Transit[5]

The Boston region's public transit system is a key function of the region's transportation network, and without it, automobile congestion would be significantly worse. The most recent available average numbers of weekday unlinked transit passenger trips taken are about 762,400 on the rapid transit system, 370,600 on the bus system, 133,300 on the commuter rail system, and 4,372 on commuter ferries.[6] The entire MBTA system provides slightly over 1.2 million trips per weekday.

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3 INRIX Traffic Scorecard, April 2012 (accessed online June 25, 2012).

4 Texas Transportation Institute, "Urban Mobility Report," 2010.

5 Because the American Public Transit Association distinguishes between heavy rail and light rail, statistics for the MBTA's rapid transit system separate the Green Line and Mattapan High-Speed Line from the Blue, Orange, and Red lines. However, in the remainder of this report, MBTA rapid transit is generally treated as a single system.

6 American Public Transportation Association, APTA 2011 Q3 Ridership Report, December 2011.

Comparison of Public Transit Services

According to the American Public Transit Association, public transit services in Boston compare to those of other metro regions as follows. The MBTA's commuter rail system is the fifth busiest in the nation, with slightly higher ridership than Philadelphia's system (SEPTA) and much lower ridership than Chicago's main system (METRA) and the three systems in the greater New York City region (New Jersey Transit, Long Island Railroad, and MTA).

- Together, the Green Line and Mattapan High-Speed Line constitute by far the busiest light rail transit system in the United States, with an average of 232,000 weekday boardings. This ridership has 60,000 more weekday boardings than San Francisco's Municipal Railway, which is the second-busiest light rail system in the United States.[7]
- The Blue, Orange, and Red lines, with an average of 530,400 weekday boardings for all three lines combined, constitute the fourth-busiest heavy rail rapid transit system in the United States, significantly more heavily used than the San Francisco Bay Area Rapid Transit (BART) system, and less heavily used than the rapid transit systems of New York, Washington, D.C., and Chicago.
- The MBTA bus system is the seventh-busiest system in the nation, with 370,600 weekday boardings, just behind that of Washington, D.C., and ahead of San Francisco's Municipal Railway Service.

Other Modes

According to U.S. Census Bureau, for the years 2005 to 2009 an estimated 98,463 residents of the Boston Region MPO area commuted to work by walking, and 15,695 bicycled to work.[8] These statistics do not include trips taken by foot and by bicycle for purposes other than commuting. Census estimates show that about 36% of workers in the MPO region commute by means other than driving alone.

When comparing the Boston region to other regions, Metropolitan Statistical Areas (MSAs), which are defined by the U.S. Office of Management and Budget and used by the U.S. Census Bureau and other U.S. government agencies for statistical purposes, provide a useful approximation of the boundary of the urban area. Although MSAs do not necessarily have the same boundaries as MPO regions, they are similar in that they cover an urban area that extends beyond city limits; in addition, data at the MSA level are readily available from the Census Bureau. Compared to other large MSAs with over

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[7] United States Census Bureau. American Community Survey data (last accessed June 14, 2011).

[8] United States Census Bureau, American Community Survey data (accessed June 14, 2011).

one million workers, the Boston MSA, with a mode share of commuting by foot of 5.0%, ranks second only to the New York City MSA. In terms of the percentage of workers who commute by bicycle, the Boston MSA ranks sixth, with a mode share of 0.8%. This is a higher percentage than the New York City, Philadelphia, Washington, D.C., and Baltimore MSAs, but lower than the percentage in the MSAs of San Francisco, Seattle, Minneapolis, Phoenix, and Portland, Oregon. In terms of the percentage of workers who commute by carpooling, the Boston MSA ranks twenty-third among large MSAs (8.1% of workers carpool, slightly higher than the New York City MSA and lower than the Philadelphia, Baltimore, and Washington, D.C., MSAs).

THE CONGESTION MANAGEMENT PROCESS

The process model for congestion management recommended by the federal government provides an outline for an objectives-driven, performance-based approach consisting of eight actions:[9]

1. Develop regional objectives.
2. Define the CMP network.
3. Develop multimodal performance measures.
4. Collect data and monitor system performance.
5. Analyze congestion problems and needs.
6. Identify and assess strategies.
7. Program and implement strategies.
8. Evaluate strategy effectiveness.

Figure INT-2 shows how this model is used by the Boston Region MPO, and also shows the connections between the CMP and other elements in the MPO's transportation planning process.

[9] Federal Highway Administration, "Congestion Management Process: A Guidebook" (Technical report no. FHWA-HEP-11-011), April 2011, p. 9.

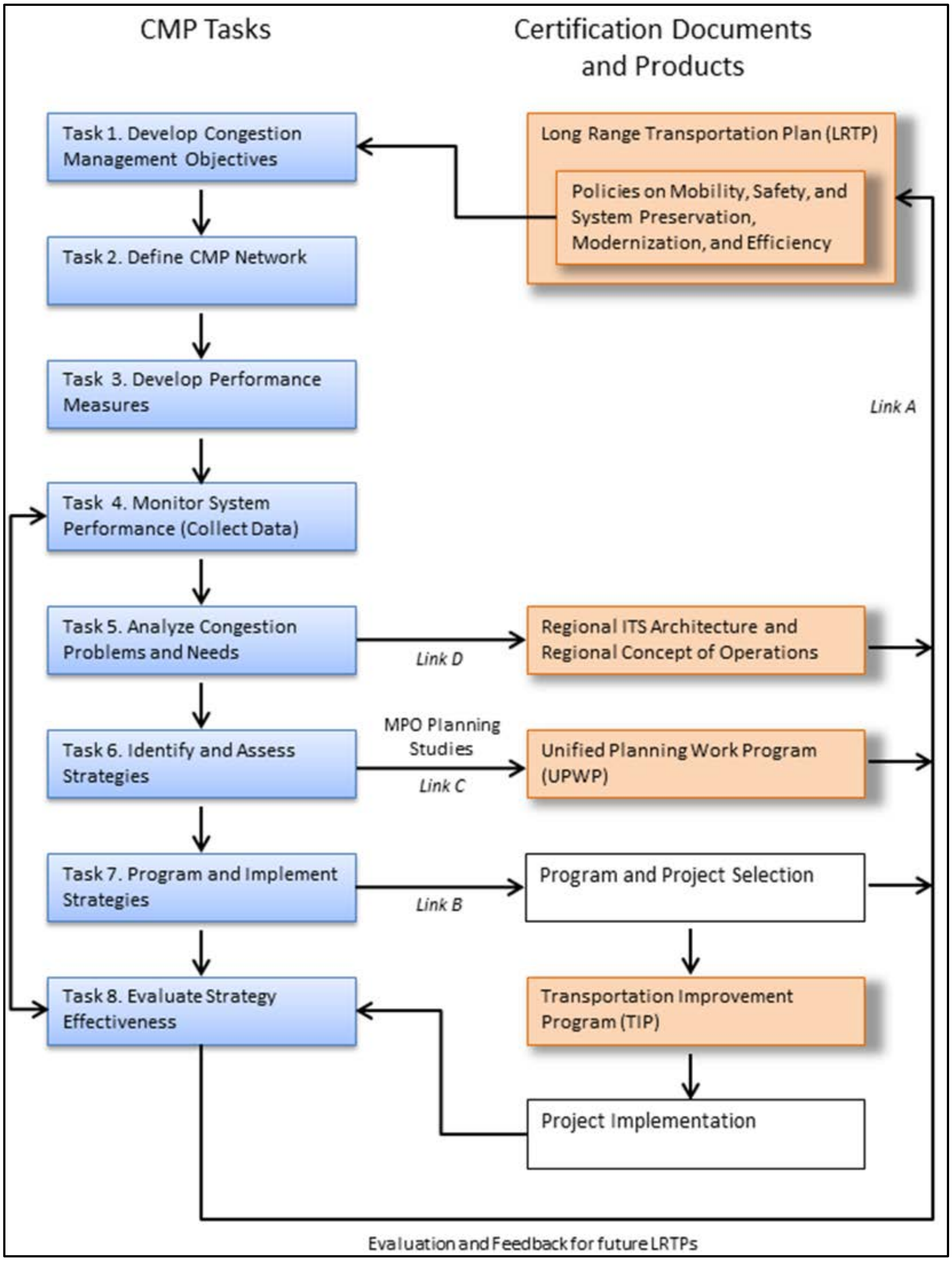

FIGURE INT-2
Boston Region Congestion Management Process

Links between the CMP and Other Planning Elements

The CMP interacts with many elements of the transportation planning process. The essential functional elements of an MPO are indicated in orange in Figure INT-2, which shows how the Boston Region MPO views the integration of the CMP with the overall metropolitan planning process, as shown by Links A, B, C, and D. These linkages are described in detail below.

Links A, B, and C show that the CMP is integrated with the LRTP, TIP and UPWP

- "Develop CMP Objectives," "Define CMP Network," "Identify and Assess Strategies," and "Evaluate Strategy Effectiveness" are steps in the Congestion Management Process that relate directly to the following elements of the LRTP: visions and policies, application area, needs assessment, and strategy development and evaluation. CMP performance monitoring is used in the needs assessments for the LRTP.
- The "Identify and Assess Strategies" section of this document identifies possible strategies that may be implemented. These strategies are mentioned in greater detail later in this document. This section also provides input into the UPWP for corridor studies and other planning studies, and, indirectly, into UPWP study recommendations for the LRTP. Some of the recommendations yielded by CMP monitoring of roadway, transit, and bicycle/pedestrian transportation studies for the UPWP have to do with:
    - Pedestrian access to transit
    - Bicycle and pedestrian access to community centers
    - Safety and operations programs for signalized intersections
    - Bottleneck studies
    - Arterial coordination

The entire CMP program is funded through the UPWP. The latest CMP work program was updated to include monitoring of vehicle occupancy for future HOV system planning and transportation demand management, the evaluation of additional intersections for needs assessment for the LRTP, and the evaluation of projects and strategies evaluations for an improved objectives-driven, performance-based approach.

"Programming and Implementing Strategies" relates to the CMP influence in the selection of projects for funding in the TIP. Monitoring data from the CMP are used in the evaluation of potential TIP projects and their prioritization for funding.

"Evaluate Strategy Effectiveness" evaluates the impacts or results of implementing the strategies in the Boston region. This step receives input from TIP projects that have been implemented in order to monitor their strategy effectiveness, which, in turn, feeds

into management and operations and other CMP recommendations for future LRTPs. This step has not been implemented in its fullest, although the MPO has recently funded the study “TIP Project Impacts, Before –After Evaluations,” completed in October 2012.

The following section describes some of the CMP-recommended studies that resulted in evaluations of improvement strategies. Many of the recommendations from these studies are already in various stages of design, implementation, and construction.

Multimodal Subarea Studies

- The Lower North Shore Transportation Improvement Study, 2000
- MetroWest Subregional Area Study, 2000
- Traffic Congestion in the SouthWest Advisory Planning Subregion, 2002
- Transportation Improvement Study of Routes 1A, 114, and 107, and Other Major Roadways in Downtown Salem, 2005
- Mid–North Shore Subregional Transportation Study, 2006
- Belmont, Lexington, Waltham Subarea Study, 2009

Expressway Planning and Operations Studies

- Feasibility Analysis of Safety and Operational Improvements at 11 Route 128 Interchanges, 2003
- I-93/Southeast Expressway/Route 3 – Braintree Split, 2006
- Safety and Operational Improvements for the I-93/Route 24 Interchange, 2007
- Newton Corner Rotary Study – Phase II, 2009
- Alewife Traffic Operations and Access Study – Phase II, 2009
- Freeway Bottlenecks, 2009
- Freeway Bottlenecks, 2011

Corridor Planning and Operations Studies

- Route 138 Corridor Planning Study, 2001
- Route 53 Corridor Transportation Plan, 2003
- Route 28 Corridor Study, 2008
- Route 60 Mobility Study: Malden and Medford, 2009
- Route 126 Corridor Improvements Study, 2010

Arterial Intersections Traffic Operations Studies

- Signalized Intersection Study – North Suburban Planning Council, 2001
- Signalized Intersection Study – Minuteman Advisory Group on Interlocal Coordination, 2001
- Signalized Intersections Study – SouthWest Advisory Planning Committee, 2001
- Signalized Intersections Study – South Shore Coalition, 2001
- Signalized Intersections Study – MetroWest, 2001
- Congested Intersection Study – Three Rivers Interlocal Council, 2002
- Signalized and Unsignalized Intersections Study – North Shore Task Force, 2003
- Safety and Operational Improvements at Selected Intersections, 2008
- Arterial Traffic Signal Improvements and Coordination, 2010

Transit Planning and Operations

- MBTA Bus Route 66 Arterial Improvement Study, 2001
- MBTA Transit Signal Priority Study: Arborway Corridor, 2008
- MBTA Route 1 Transit Signal Priority Study, 2011
- Strategic Visioning for MBTA Bus Service, 2011

Studies for Various Modes of Travel

- MassHighway Park-and-Ride Lot Status and Recommendations, 2003
- Improving Pedestrian and Bicyclist Access to Selected Transit Stations, 2005

Link D: CMP Connections with Regional Concept of Transportation Operations and Boston Region Intelligent Transportation Systems (ITS) Architecture

The current LRTP, *Paths to a Sustainable Region* (endorsed in September 2011), includes management and operations (M&O) and ITS considerations by regional corridor.[10] The M&O strategies are consistent with CMP findings and with the needs and strategies identified in the current LRTP. The following activities have been undertaken:

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[10] Boston Region Metropolitan Planning Organization, Long-Range Transportation Plan, Paths to a Sustainable Region, Chapter 4, "Transportation System Operations and Management," endorsed September 22, 2011.[11] MassDOT, Regional Transportation Operations Strategy, Boston Metropolitan Region, March 2010.

- The MPO's Transportation Improvement Program (TIP) for federal fiscal years 2013–16 includes funding for ITS projects along I-95 and I-495, including expansion of fiber-optic cable, CCTV (closed-circuit television), VMS (variable message signs), wireless sensor networks, and other communications infrastructure.
- The CMP has recommended several TSP (transit signal priority) studies in the region, and funding has been identified for them. Several TSP studies have already been performed, and the MBTA is considering recommendations for implementation. Data from CMP monitoring, and from the MBTA's service planning forms the basis for a strategy assessment of bus transit-signal priority.
- The MPO staff has participated in a statewide effort to assess costs associated with maintaining and operating the existing Federal Aid Highway System in the Boston region.
- MPO staff and MPO member agency representatives have participated in ITS architecture updates since the first Metro Boston Early Deployment Plan for Intelligent Vehicle Highway System (IVHS) was completed in 1994. It is expected that MPO member agency representatives and staff will participate as stakeholders in MassDOT's ITS Implementation Plan.
- MPO staff has participated in a survey, managed by MassDOT Office of Transportation Planning (OTP), of an electronic data-sharing program.
- MPO staff is participating in the City of Boston–led effort to integrate transportation data from a variety of sources, including CCTV and traffic detection systems, into a dynamic database system.
- CMP staff is making progress toward switching roadway speed monitoring to vendor-provided speed data collected from various digital sources.
- The UPWP has included studies on arterial and corridor traffic signal improvements, including arterial signal coordination.
- The TIP has called for technology and communications upgrades for the traffic control center of the City of Boston, which is a member of the MPO.
- In 2010, the MPO proposed that its Clean Air and Mobility program should fund a traffic-signal retiming program for the City of Newton.
- The LRTP's visions and goals include support for ITS technology.
- CMP staff has recommended that the current LRTP incorporate ITS communication and technology needs and strategies from MassDOT's draft report

about the Metropolitan Boston 2010 Regional Transportation Operations Strategy.[11]

The eight steps of the Boston Region MPO's Congestion Management Process are described in detail in this document.

[11] MassDOT, Regional Transportation Operations Strategy, Boston Metropolitan Region, March 2010.

GOALS AND OBJECTIVES

BACKGROUND

Because the CMP is integrated into the MPO's long-range planning process, the goals and objectives for congestion management in the Boston region are consistent with the MPO's Long-Range Transportation Plan (LRTP). The current LRTP, *Paths to a Sustainable Region* (covering the period up to 2035), contains policies for guiding MPO actions and visions for the region's future. The goals and objectives of the CMP are developed in accordance with those visions and policies.

The MPO's visions and policies are organized in several categories relating to various aspects of the future of transportation in the region. Of those categories, the CMP relates directly to the following:

- System preservation, modernization, and efficiency
- Mobility
- Safety and security

The CMP has three goals, corresponding to the three LRTP categories of vision and policies listed above:

- Improve efficiency
- Increase mobility
- Improve safety

CMP GOALS

Goal 1: Improve Efficiency

Objective: Reduce congestion with cost-effective, non-roadway-widening solutions that use technology to the best advantage, such as traffic management and transportation demand management.

Goal 2: Increase Mobility

Objective: Make non-single-occupant-vehicle transportation modes (walking, bicycling, transit, carpooling) more available, convenient, safe, and attractive for everyone.

Goal 3: Improve Safety

Objective: Reduce crashes for all modes, focusing especially on improving safety for pedestrians and bicyclists and on reducing the number of crashes.

The MPO policies and associated CMP objectives, performance measures, and strategies are shown in Table 1-1**.**

TABLE 1-1
Relationship between MPO Policies and Visions and
CMP Goals, Objectives, Performance Measures, and Strategies

CMP Goals and Objectives	Related MPO Policies	Related MPO Visions	Related Strategies	Performance Measures
Goal: Improve Efficiency • Objective: reduce congestion with cost-effective, non-widening solutions that use technology to the best advantage, such as traffic management and transportation demand management	*System Preservation, Modernization, and Efficiency* • Put a priority on programs, services, and projects that maximize efficiency through ITS, technology, TSM, and M&O; turn to technology before expansion	*System Preservation, Modernization, and Efficiency* • System achieves maximum efficiency, reliability, and mobility (regionwide) through system preservation, ITS, technology, management and operations (M&O) programs, and a balanced program of strategic investments • Innovative approaches reduce auto dependency and actively promote other modes • Modernization of the existing system provides accessibility and access for all; serves more people	• Real-time traffic monitoring and management systems • Integration of the payment system for tolls, park-and-ride lots, and transit • Improved response to weather and road surface problems • Access management • Metered ramps • Transit signal priority • New HOV lanes • Reversible commuter lanes and movable median barriers • Incident management systems • Work-zone management systems • Weather-related diversion plans	• Travel speed • Speed index • Delay • Traffic volume • Vehicle occupancy • Level of service • Approach speed • Approach delay • Volume/capacity ratio • Travel time savings (HOV lanes)
Goal: Increase Mobility • Objective: make non-single-occupant-vehicle transportation modes (walking, bicycling, transit, carpooling) more available, convenient, safe, and attractive for everyone	*Mobility* • Strengthen connections between modes; close gaps in the existing network • Improve access and accessibility to transit • Improve transit frequency, span, and reliability • Expand transit, bicycle, and pedestrian networks; focus bicycle investments (lanes and paths) on moving people between activity centers (and access to transit) • Integrate payment methods for fares and parking across modes. • Support TDM, TMAs, shuttles, and carpooling • Seek low-cost solutions to capacity constraints and bottlenecks in the existing system before expansion	*Mobility* • There are more transportation options and accessibility for all; all modes (including freight); all corridors • System provides reliable service; delays, congestion, and travel time are reduced • Transit ridership and use of sustainable options are increased • The system meets people's needs; funding is guided by attention to customer service • Existing transit, bicycle, and pedestrian facilities are linked in a network	• Provide and market real-time information on travel conditions, alternate routes, and alternate modes • Provide transit users with real-time transit arrival information • New bus rapid transit routes • Increase transit frequency and span • Improvements to bicycle and pedestrian routes that lead to transit stops • Provisions for bicycles at transit stops and on transit vehicles	• Vehicle occupancy • On-time performance • Passenger crowding • Lot capacity and utilization • Time a lot fills up • Bicycle parking availability and utilization • Number of crashes (involving bicyclists/pedestrians) • Crash rate (involving bicyclists/pedestrians)
Goal: Improve Safety • Objective: reduce crashes for all modes; focus especially on improving safety for pedestrians and bicyclists, and on reducing the number of incident-related crashes	*Safety and Security* • Maintain the transportation system in a state of good repair • Use state-of-the-practice safety elements; address roadway safety deficiencies (after safety audits) and transit safety requirements (including federal mandates) • Support incident management programs and ITS • Improve safety for pedestrians and cyclists; ensure that safety provisions are incorporated into shared-use corridors • Give priority to safety projects that reduce the severity of crashes, especially those that improve safety for all	*Safety and Security* • The transportation system provides safe transportation (personal and operational) on all modes • The number and severity of crashes are reduced • Transit has state-of-the-practice ITS and communication systems; transit malfunctions are reduced	• Optimization of traffic signal timing • Geometric improvements to roads and intersections • Geometric improvements to roads and intersections • Improvements to bicycle and pedestrian routes that lead to transit stops	• Number of crashes (all modes) • Crash rate (all modes)

The CMP Network

BACKGROUND

Generally speaking, the Congestion Management Process is applied to the Boston Region MPO area. This region includes 101 cities and towns in eastern Massachusetts, within a radius of roughly 20 miles of the city of Boston. These municipalities are listed in Table 2-1.

In addition, in order to provide a comprehensive regional approach to congestion management, the CMP reaches beyond the MPO region for some types of monitoring. Several regionally significant roadways beyond the MPO boundary are included, as well as the entire MBTA commuter rail system. This section describes the CMP area of application in detail (Figure 2-1) in terms of the various transportation facilities that are monitored.

ROADWAY NETWORK

The CMP roadway network includes all roadways in the Boston region that are functionally classified as principal (major) arterials and all limited-access highways (often called expressways or freeways), as well as some minor arterials. This network comprises about 900 centerline miles (or 1,800 miles, bidirectional) of arterial roadways and 377 centerline miles of limited-access highways—more than 10% of all roadways in the region, and about 50% of the Federal-Aid Highway System. Most state-numbered roadways are included in the monitored network, as are most corridors of the National Highway System. In general, the volumes on these roadways exceed 10,000 vehicles per day. Most of the arterial roadways typically handle over 27,500 vehicles per day on some portion of their length.

Volumes on the limited-access highways in the Boston region typically range from 40,000 to 235,000 vehicles per day. The CMP network is dynamic, meaning that any given monitoring effort may include additional roads; conversely, not all roadways are monitored in all monitoring efforts.

The CMP roadway network goes beyond the boundary of the Boston Region MPO area to include most of the limited-access highways and major arterials within I-495. The network is illustrated in Figure 2-2.

TABLE 2-1
Boston Region MPO Cities and Towns

City	Town		
Beverly	Acton	Holbrook	Pembroke
Boston	Arlington	Holliston	Randolph
Cambridge	Ashland	Hopkinton	Rockland
Chelsea	Bedford	Hudson	Rockport
Everett	Bellingham	Hull	Saugus
Gloucester	Belmont	Ipswich	Scituate
Lexington	Bolton	Lincoln	Sharon
Lynn	Boxborough	Littleton	Sherborn
Malden	Braintree	Lynnfield	Southborough
Marlborough	Brookline	Manchester	Stoughton
Medford	Burlington	Marblehead	Stow
Melrose	Canton	Marshfield	Sudbury
Newton	Carlisle	Maynard	Swampscott
Peabody	Cohasset	Medfield	Topsfield
Quincy	Concord	Medway	Wakefield
Reading	Danvers	Middleton	Walpole
Revere	Dedham	Milford	Wayland
Salem	Dover	Millis	Wenham
Somerville	Duxbury	Milton	Weston
Stoneham	Essex	Nahant	Westwood
Waltham	Foxborough	Natick	Weymouth
Watertown	Framingham	Needham	Wilmington
Wellesley	Franklin	Norfolk	Winchester
Woburn	Hamilton	North Reading	Winthrop
	Hanover	Norwell	Wrentham
	Hingham	Norwood	

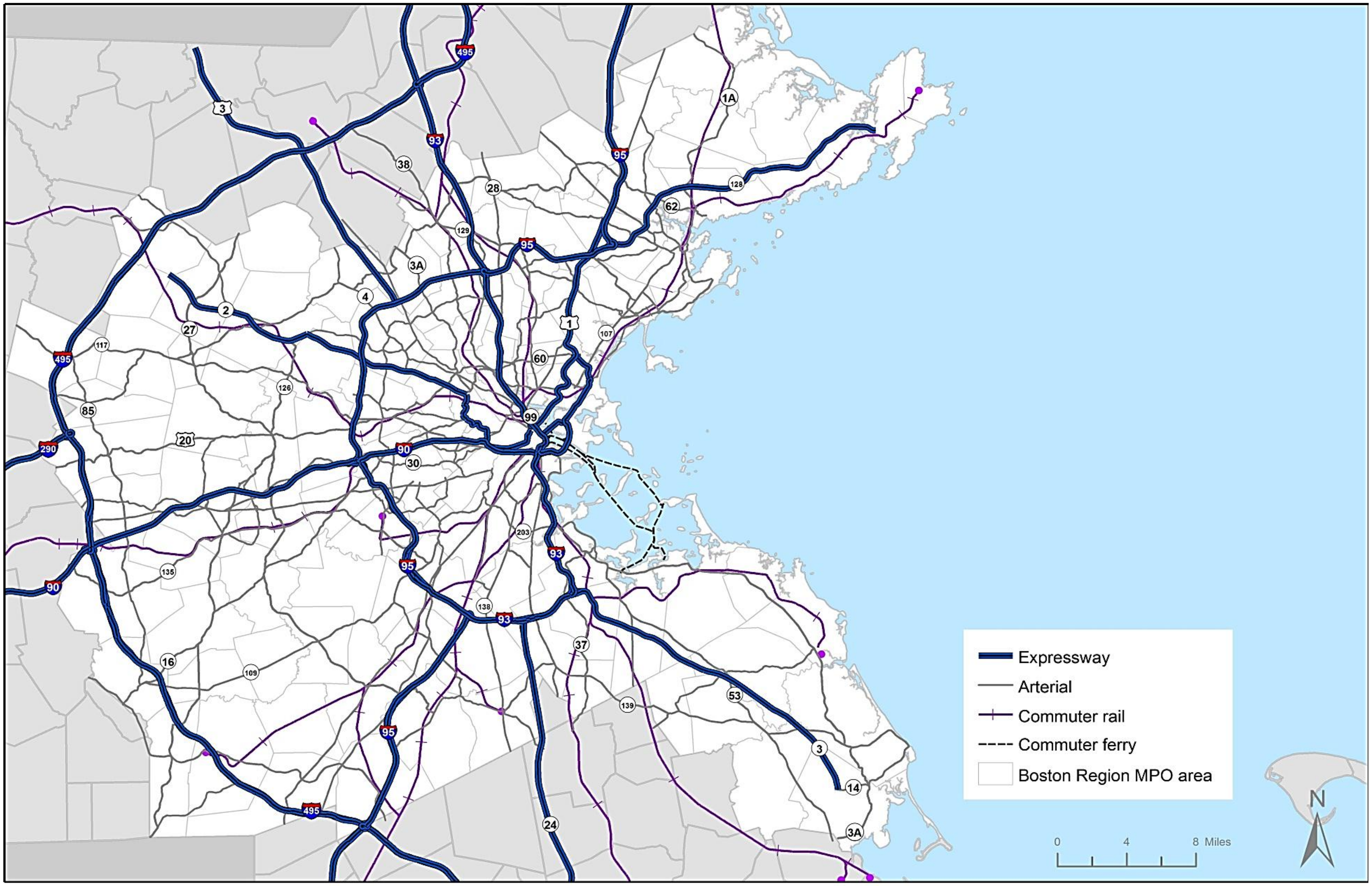

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FIGURE 2-1
CMP Area of Application
2012

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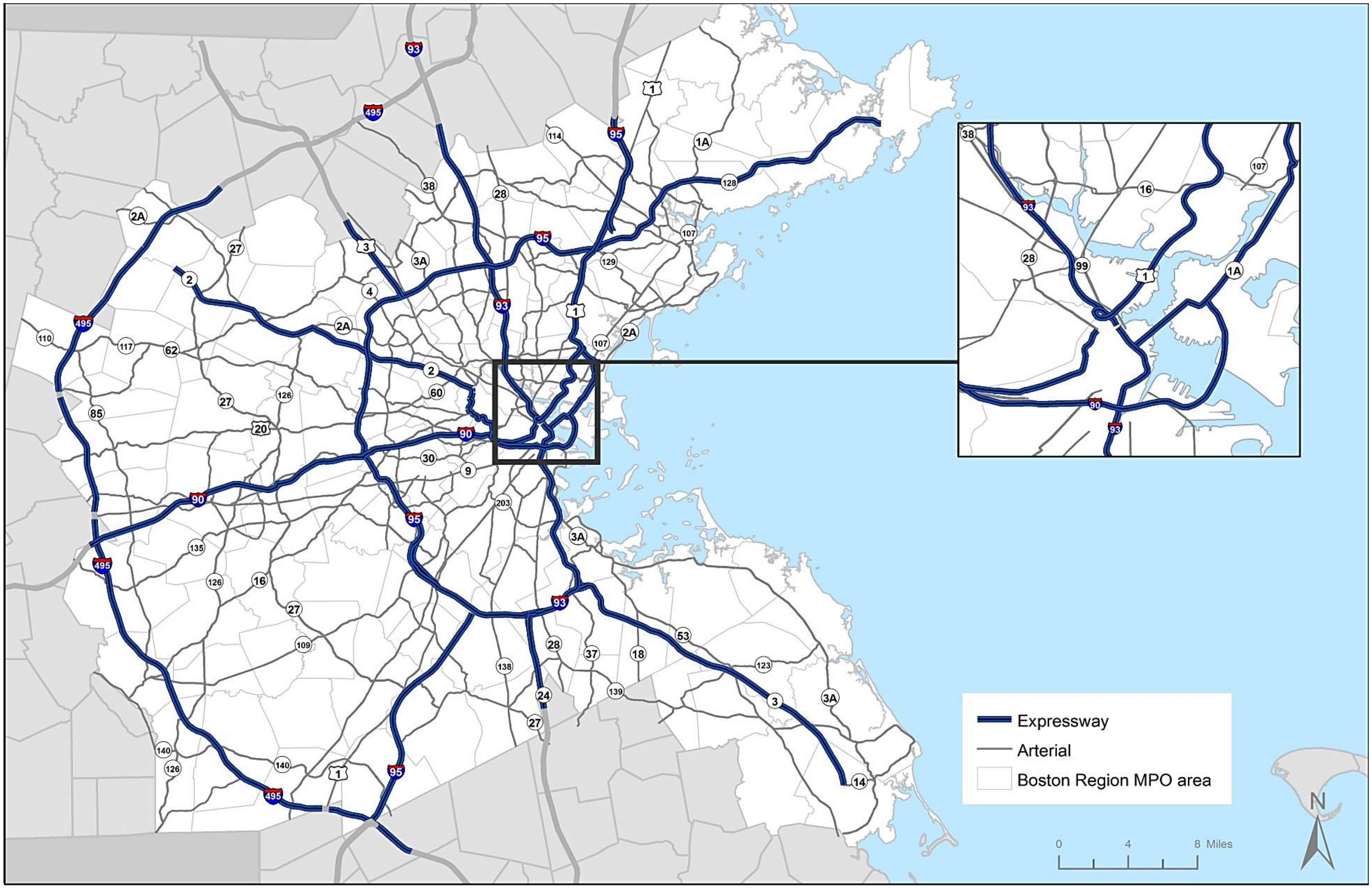

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FIGURE 2-2
CMP-Monitored Roadway Network
2012

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HIGH-OCCUPANCY-VEHICLE (HOV) LANES

Two HOV lanes operate on the CMP network,[1] both on Interstate 93. The I-93 North HOV lane, north of downtown Boston, operates in the inbound direction (toward Boston) in the mornings; the Southeast Expressway HOV lane, south of downtown Boston, operates in the inbound direction in the mornings and in the outbound direction in the afternoons. The HOV lanes are illustrated in Figure 2-3.

The I-93 North HOV lane is a southbound, buffer-separated lane that currently operates between 6:00 AM and 10:00 AM, Monday through Friday. It extends 2.6 miles from a point 0.3 mile south of Exit 31 (Mystic Avenue) in Somerville to 0.2 mile south of the Route 1 merge on the Leonard P. Zakim Bunker Hill Memorial Bridge over the Charles River. During its times of operation, this HOV lane is open to vehicles with two or more occupants and to all motorcycles. The lane is open to all traffic at all other times.

The I-93 Southeast Expressway HOV lane is a reversible, barrier-separated “zipper” lane that currently operates between 6:00 AM and 10:00 AM in the northbound direction and between 3:00 PM and 7:00 PM in the southbound direction, Monday through Friday. Specialized machinery is used to move the barriers into place each weekday. The lane extends 5.5 miles from a point 0.24 mile north of the merge of I-93 and Route 3 merge in Quincy to a point 0.9 miles south of Columbia Road in Dorchester. The lane’s contraflow system “borrows” one of the general-purpose lanes in the off-peak direction and converts it to a peak-direction HOV lane that is open to carpools (cars with two or more occupants), vanpools, buses, and motorcycles. The HOV facilities on the Massachusetts Turnpike (I-90) are not monitored by MPO staff.

PUBLIC TRANSIT

Public transit in the area monitored by the CMP is provided by the Massachusetts Bay Transportation Authority (MBTA). The MetroWest Regional Transit Authority (MWRTA) and Cape Anne Transit Authority (CATA) and several other providers of local, intra-town services, as well as express commuter service exist within the area monitored by the CMP, even though they are not monitored by the CMP. The commuter rail system consists of 14 lines that provide regular service to 133 stations. The rapid transit system consists of three heavy rail lines (the Blue, Orange, and Red Lines), the Green Line with its four branches (B, C, D, and E), and the Mattapan High-Speed Line, serving a total of 135 stops.[2] The MBTA bus system consists of 187 bus routes, including local routes,

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[1] Three HOV lanes operate in the region’s network; the CMP monitors two, the subject of this section. The Central Artery/Tunnel (CA/T) HOV lanes which were constructed as part of the CA/T are not monitored by the CMP.

[2] MBTA, “Subway Map.” Available online at http://www.mbta.com/schedules_and_maps/subway/ (accessed June 5, 2012).

inner express routes, outer express routes, “trackless trolley” routes powered by overhead electric wires, and four bus rapid transit routes (the four branches of the Silver Line). The commuter boat system consists of three routes, including the Inner Harbor Ferry. The public transit network, excluding the bus route network, is illustrated in Figure 2-4. The vehicle-miles traveled per capita in relation to this network are illustrated in Figure 2-5. It is interesting to note that this measure roughly varies inversely with distance from the core. The CMP does not collect monitoring data for any MBTA services except park-and-ride lots because extensive monitoring and evaluations are done by the Service Planning Department of the MBTA, especially for buses. In addition, the CTPS Transit Service Planning staff performs monitoring and evaluation functions through contracts with MassDOT and the MBTA. The CMP staff often gathers data from the MBTA for monitoring bus schedule adherence and seating capacity.[3]

3 The MBTA uses passenger load adherence as a performance measure to measure seating capacity instead of passenger crowding, which is the Boston Region Metropolitan Planning Organization’s performance measure.

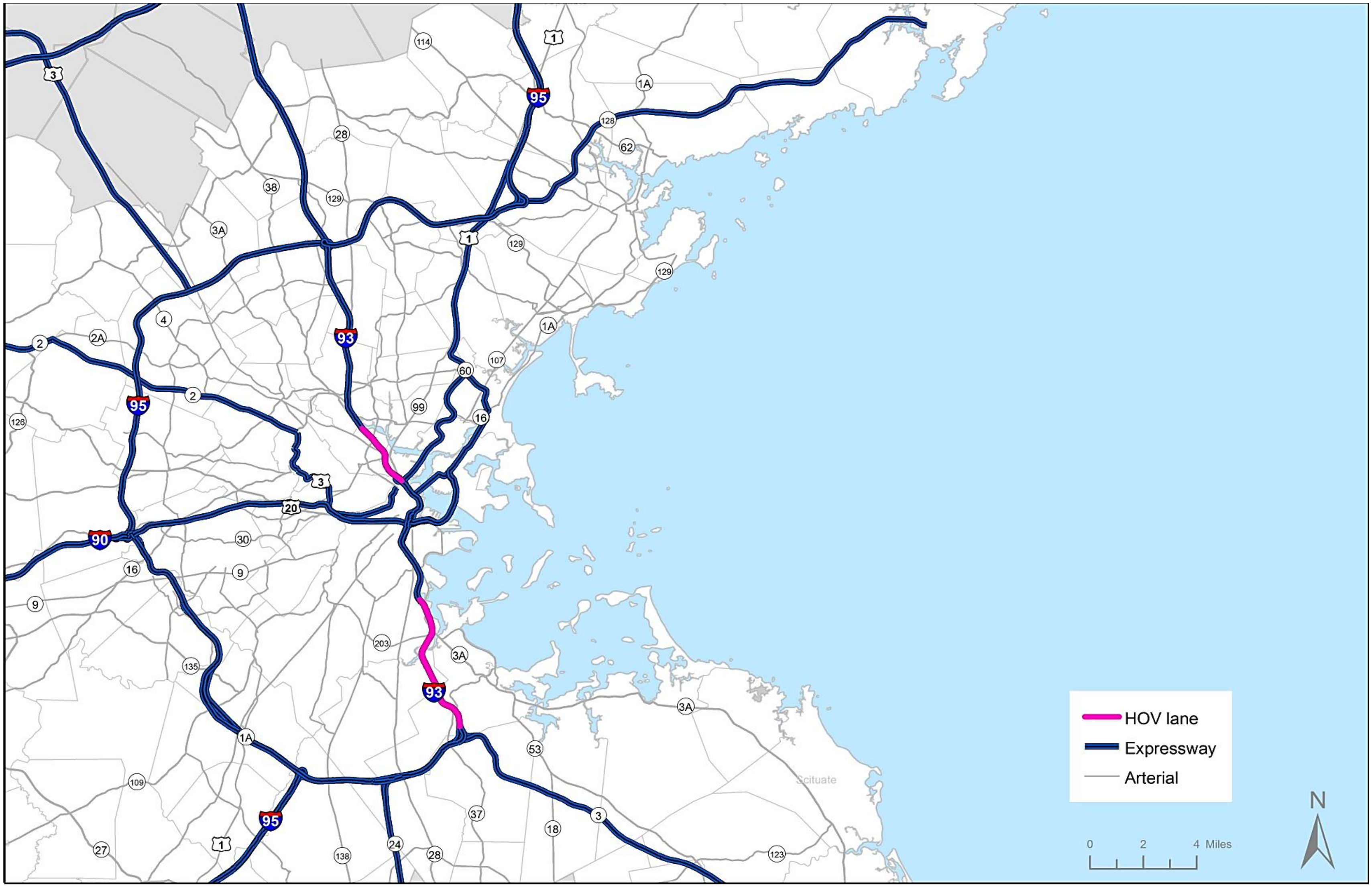

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FIGURE 2-3
CMP-Monitored HOV Facilities
2012

Congestion Management Process

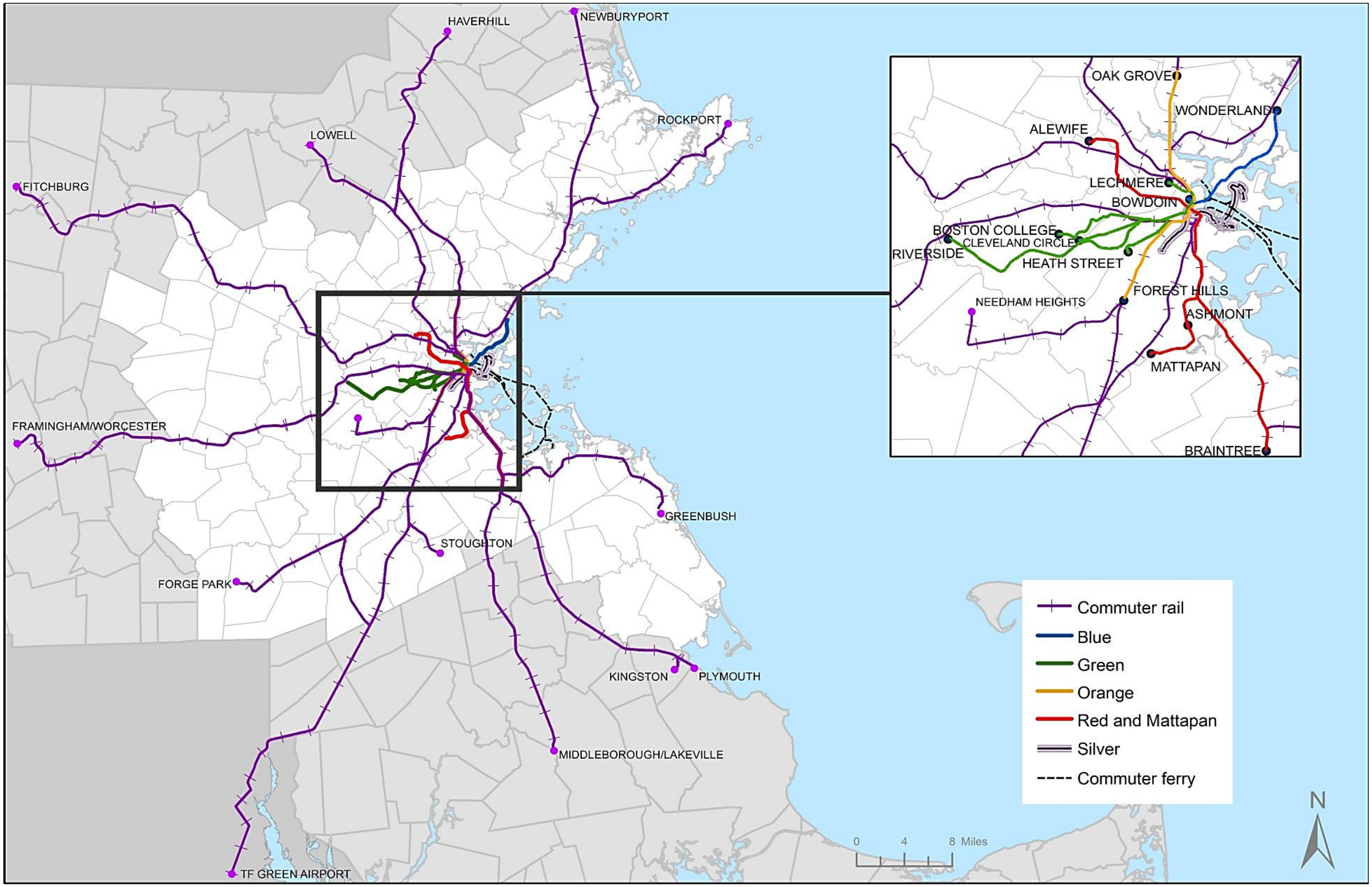

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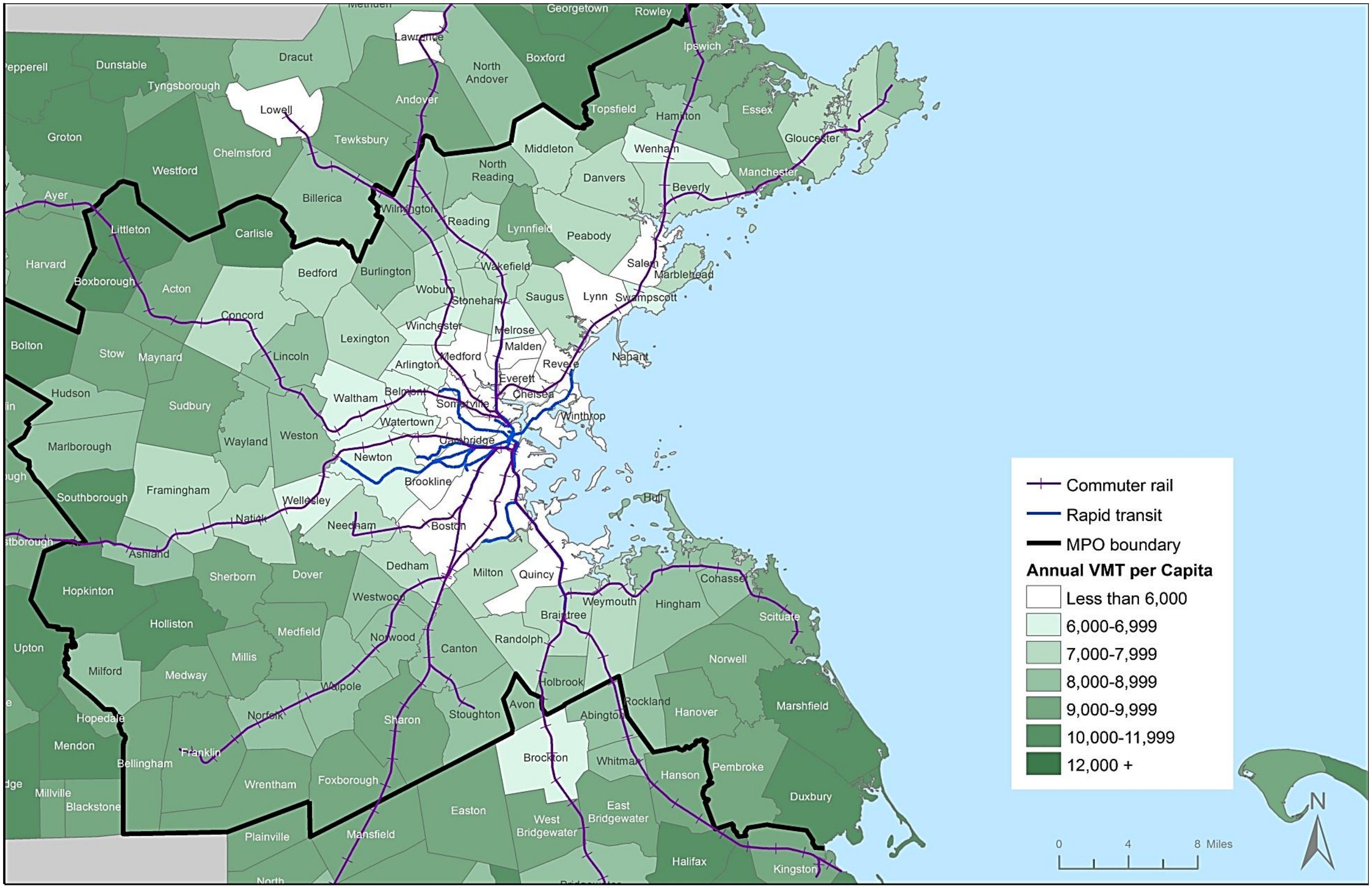
FIGURE 2-4
Public Transit Network (Excludes Local Bus Network)
2012

Congestion Management Process



BOSTON REGION MPO

FIGURE 2-5
Vehicle-Miles Traveled per Capita
2005-07

Congestion Management Process

PARK-AND-RIDE LOTS

The CMP monitors park-and-ride facilities at MBTA stations and MassDOT lots. Bicycle parking is also monitored. Within the MBTA system, according to the most recent inventory, automobile parking is available at 114 commuter rail stations, 28 rapid transit stations, three boat terminals, and one express bus origin location. Bicycle parking facilities are also available at most of these stations.

The most recent inventory, conducted between January 2009 and August 2010, indicated that a combined 58% of parking spaces at all stations for all modes in the MBTA system were used on a typical weekday morning. The breakdown by type of service was 56% utilization for the commuter rail system, 61% utilization for the rapid transit system, 93% utilization for express bus lots, and 69% utilization for commuter boat lots. This report includes an overview of the results of MBTA park-and-ride lot monitoring (see the Problem and Needs section for details).

In addition to MBTA lots, the CMP monitors MassDOT-operated park-and-ride lots, which are designed to encourage carpooling and vanpooling. The data collection for these lots is currently performed by MassDOT. For an overview of the results of this data collection, see the Problem and Needs section .

BICYCLE FACILITIES

Fewer than 2% of roadway centerline miles throughout the Boston Region MPO area have bicycle-specific accommodations, such as bike lanes.[4] Bicycles are allowed on all roads except limited-access highways. The Boston region network of bicycle-specific facilities includes on-street bike lanes, separate shared-use paths, and roadway lanes marked with sharrows, which are shared-lane markings indicating that motor vehicles need to share that section of roadway. There are also some lanes that are restricted to buses and some that are restricted to bicycles. In addition, less experienced and younger bicyclists may ride on some sidewalks (though this is generally prohibited in central business districts). There are also innovative bicycle facility designs in the region, such as the barrier-separated bike lanes (cycle tracks) on Vassar Street in Cambridge.

Facilities for linking bicycle travel to transit include bicycle parking at transit stations (for a full discussion of this, see the Bicycle and Pedestrian Facilities subsection of System Monitoring), bike racks on buses, and the option of transporting bicycles on trains at certain times. Most rapid transit and commuter rail stations now have bike racks, and two rapid transit stations (Alewife and Forest Hills) have secure keycard-access bicycle parking. Buses on 72 MBTA bus routes now have bicycle racks. Each bus can carry two

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[4] Boston Region MPO Long-Range Transportation Plan, Volume II (Needs Assessment), endorsed by the Boston Region MPO on September 22, 2011.

bicycles. Outside of peak commuting hours, bikes can be taken on heavy rail rapid transit trains (the Blue, Red, and Orange lines) and commuter trains.[5] Bicycle cages are currently located at three MBTA stations, including Alewife (232 spaces), Forest Hills (80 spaces), and South Station (64 spaces).

The Hubway system is a newly implemented bike-sharing system in the metro region that was launched in July 2011. There are currently over 60 stations operating, with over 600 bicycles available, and there are plans to add more stations soon. It is a convenient service for casual bicyclists because bicycles can rented for half-hour increments and returned at any station.

PEDESTRIAN FACILITIES

According to the U.S. Census Bureau's 2006–10 estimates, more than 101,400 residents of the Boston Region MPO area walk to work, constituting just over a 6% mode share for all commuters. In addition, walking is the mode used for approximately half of all trips to MBTA rapid transit stations.

Regionwide, only 50% of non-interstate roadway centerline miles have sidewalks. Within the MPO region, this varies from 85% in the Central Corridor to 41% in the Southeast Corridor,[6] as defined by the FFY 2011 LRTP Needs Assessment.[7] Multi-use paths (for bicycling and other nonmotorized uses) are another important component of the pedestrian transportation network.

[5] MBTA, "Bikes and the T." Available online the MBTA's website, www.mbta.com (accessed June 15, 2011).

[6] Southeast Corridor – Interstate 93, Routes 3 and 24, the Middleborough/Lakeville, Kingston/Plymouth, and Greenbush lines of the commuter rail system, and the Red Line of the rapid transit system.

[7] Boston Region MPO Long-Range Transportation Plan, Volume II (Needs Assessment), endorsed by the Boston Region MPO on September 22, 2011.

Performance Measures

The CMP is multimodal; it monitors limited-access and arterial roadways, interchanges, intersections, park-and-ride lots, bicycle parking at transit stations, pedestrian and bicycle transportation (as part of intersection monitoring), carpool and vanpool park-and-ride facilities, transit schedule adherence, and transit vehicle capacity.

The MPO staff collects data by facility type. For additional analysis, the CMP acquires data from other sources, such as the U.S. Census Bureau, the MBTA, and MassDOT. The data are matched to performance measures, many of which are associated with thresholds. Depending on the situation, selected performance measures are mapped, tabulated, or used as input for level-of-service analysis in order to estimate performance based on level of service (LOS), utilization rates, speed indices, crash rates, and other measures. Based on performance measures, congested locations are prioritized for recommendations for planning studies in the UPWP (Unified Planning Work Program), for project evaluation and prioritizing in the TIP (Transportation Improvement Program), and for the Needs Assessment in the LRTP (Long-Range Transportation Plan).

The following performance measures are used by the CMP, organized by facility type.

Roadways, Intersections, and Interchanges

- **Average observed travel speed:** Travel speeds are associated with specific roadway segments and are calculated using travel times. The average observed travel speed is a good indicator of a deficiency in mobility in the roadway network and is used for determining solutions to mobility problems. Travel times are collected for limited-access, partially limited-access, and arterial roadways. Congestion is considered to occur when average observed travel speeds are less than 50 mph on limited-access roadways, equal to or less than 21 mph on partially limited-access arterials, or equal to or less than 14 mph on other arterials.
- **Speed index:** The speed index is the ratio of the observed speed to the posted speed limit. The posted speed limit is one of the factors that influence travel speeds on roadways. Therefore, in order to complement the average observed travel speeds, a speed index is used to account for the speed limit factor. The

index helps to determine whether a low observed speed is due to congestion or simply to a lower posted speed limit.

- **Delay:** This measure indicates if there is excessive travel delay at a particular intersection. The average delay was defined as the number of seconds for which travel speed is less than 5 mph. Delay is considered to occur when travel speed remains below 5 mph for more than three consecutive seconds. The amount of delay is used to define congestion. Delay can indicate how efficiently an intersection is operating, and can help determine if the intersection is in need of traffic operations or intelligent transportation systems (ITS) solutions. However, measuring delay is only one aspect of evaluating signalized intersections. The Highway Capacity Manual strongly recommends that any analysis of signalized intersections include both a capacity analysis and an LOS analysis in order to obtain a complete picture of existing intersection operations.[1] In other words, the CMP analysis should be viewed as a cursory assessment of signalized intersections; more data would need to be collected in order to determine the severity of problems for a specific traffic signal operation.
- **Traffic volume:** This is defined as the number of vehicles that pass through a given observation point during a given time period. Pedestrian and bicycle traffic volumes are also measured on non-limited-access roadways. Traffic volume is a factor that is considered in determining where there might be issues with safety and system preservation on the roadway network. The volume-to-capacity (V/C) ratio and many safety performance measures are dependent on the traffic volume variable.
- **Volume/capacity (V/C) ratio:** This measure is defined as the ratio of the traffic volume to capacity. Capacity is the maximum hourly rate at which vehicles can reasonably be expected to proceed through an intersection under prevailing roadway, traffic, and control conditions. A V/C ratio at or above 1.0 indicates that an intersection operates at or beyond its capacity. The V/C ratio is an indicator of where mobility might be an issue due to roadways having traffic volumes that exceed their capacity.
- **Level of service (LOS):** A measure describing operational conditions at an intersection, based on intersection delay, with LOS A representing the best conditions and LOS F the worst. Typically, a level of service of E or F is considered to indicate an unacceptable level of congestion.
- **Approach speed**: The average speed at which traffic approaches an interchange.

[1] Transportation Research Board. *Highway Capacity Manual*. Washington, D.C., TRB, 2010.

- **Approach delay (intersections):** The total additional travel time experienced by a driver as a result of traffic control measures (for example, signals) and interaction with other users of an intersection.
- **Number of crashes:** The number of crashes that have occurred at a given location within a given time period. This can indicate where there are problems related to safety, incident response, and mobility. This variable is needed to calculate the crash rate.
- **Crash rate:** The crash rate for an intersection is expressed in crashes per million entering vehicles (MEV), and the crash rate for a roadway segment is expressed in crashes per million vehicle-miles traveled (MVMT). This measure is a better indicator than the number of crashes for analyzing dangerous locations on the roadway network. The crash rate evaluates the amount of incidents relative to the amount of traffic at a particular location.
- **Vehicle occupancy:** The number of persons in each vehicle; measured at selected locations.

HOV Lanes and Parallel General-Purpose Lanes

- **Travel-time savings:** The average travel times for HOV lanes are compared to the average travel times for the adjacent general-purpose lanes during the hours of HOV lane operation. This allows the amount of time saved by HOV lane users to be calculated; it is a measure of the effectiveness of the HOV lanes.
- **Vehicle occupancy:** This measure allows the person-throughput of the HOV lanes to be calculated and compared with the person-throughput of the general-purpose lanes.

Transit Service

- **On-time performance (schedule adherence):** Different thresholds for on-time performance are used for different modes of public transportation (bus, rapid transit, commuter rail, and ferry). They are described in detail in the Public Transit section of System Monitoring.
- **Passenger crowding (passengers per vehicle seat):** Passenger crowding is a measure of the ratio of passengers to the number of seats on the vehicle. For CMP purposes, MBTA thresholds for passenger crowding are used. They are described in detail in the Public Transportation section of System Monitoring .

Park-and-Ride Facilities (MBTA and MassDOT Facilities)

- **Park-and-ride lot utilization:** The percent of parking spaces that are filled at the time of the last morning peak-period train, bus, or boat. (The peak period is defined by the MBTA; it varies depending on the transit line and station.) A park-and-ride lot is categorized as “full” if 85% or more of the spaces are used,

"partially full" if between 50% and 84% of spaces are used, and "underutilized" if less than 50% of spaces are used.

- **Time a lot fills up:** For park-and-ride lots that fill up to 85% capacity or higher during the morning peak period on a typical weekday, the time at which a lot fills up is used as an additional performance measure. There is considered to be insufficient parking capacity if the lot fills completely before the departure time of the last peak-period train.
- **Bicycle parking availability and utilization:** The number of bicycle parking spaces (for example, bike racks) available and the percentage of them that are used at the time of the last peak-period train, bus, or boat. Bicycle parking at locations other than bike racks (for example, bikes locked to sign posts) is also measured, since this may indicate the need for proper bicycle parking facilities.

The connections between performance measures, CMP objectives, and MPO policies are shown in Table 1-1, and the data sources for the performance measures are listed in Table 3-1.

TABLE 3-1
CMP Performance Measures and Data Sources

Facility	Performance Measure	Data Source
Roadways, Intersections, and Interchanges	Average observed travel speed	CTPS travel speed runs
	Speed index	CTPS travel speed runs
	Delay	CTPS travel speed runs
	Traffic volumes (all modes)	MassDOT and CTPS intersection site visits
	Volume/capacity (V/C) ratio	CTPS intersection site visits
	Level of service	CTPS intersection site visits
	Approach speed	CTPS travel speed runs
	Approach delay	CTPS intersection site visits
	Number of crashes	MassDOT crash data
	Crash rate	MassDOT crash data
	Vehicle occupancy	CTPS occupancy and traffic counts
HOV Lanes and Parallel General-Purpose Lanes	Travel time savings	CTPS travel speed runs
	Vehicle occupancy	CTPS occupancy and traffic counts
Transit Vehicles	On-time performance	CTPS ride checks, MBTA data
	Passenger crowding	CTPS ride checks, MBTA data
Park-and-Ride Facilities (MBTA and MassDOT)	Lot capacity and utilization	CTPS park-and-ride site visits, MassDOT data
	Time a lot fills up	CTPS park-and-ride site visits
	Bicycle parking capacity and utilization	CTPS park-and-ride site visits

CONGESTION THRESHOLDS

Many CMP performance measures have associated thresholds that are used to identify when congestion is occurring, or to otherwise distinguish between undesirable outcomes and desirable outcomes. If the thresholds are surpassed, the transportation facility may be identified as a congested corridor

These thresholds are listed in Table 3-2.

TABLE 3-2
Congestion Thresholds

Performance Measure	Threshold
Average observed travel speed	Indicators of congestion: < 50 mph (limited-access roadways) ≤ 21 mph (partially limited-access arterials) ≤ 14 mph (other arterials)
Speed index	< 0.70 indicates congestion
Delay	≥ 55 seconds (arterials) indicates congestion
Traffic volumes (all modes)	Depends on functional class roadway capacity
Volume/capacity (V/C) ratio	> 1.0 indicates congestion
Level of service	E or F indicates congestion
Approach speed	Varies
Approach delay (interchanges)	Varies
Number of crashes	No threshold
Crash rate	MassDOT Highway Division District average. Anything higher indicates problem areas
HOV travel time savings	One minute per mile is the minimum acceptable benefit
Vehicle occupancy	No threshold
On-time performance	Varies (see page 4-8 for more information)
Passenger crowding	Varies (see Table 4-9)
Park-and-ride lot utilization	Full: ≥ 85% Underutilized: < 50%
The time a lot fills up	There is insufficient parking capacity if the lot fills to 100% before the departure time of the last AM peak-period train.
Bicycle parking capacity and utilization	Full: ≥ 85% Underutilized: < 50%

System Performance Monitoring

BACKGROUND

The following sections describe the findings of the system performance monitoring conducted by the CMP. Monitoring results are described in detail for roadways (limited-access and arterial), HOV lanes, public transit, park-and-ride lots, and bicycle and pedestrian facilities. This section applies the performance measures and thresholds to the CMP network to indicate where congestion is present. Performance monitoring is integral to determining problems when conducting a needs assessment.

ROADWAYS

The roadway network monitored by the CMP comprises approximately 900 centerline miles (or 1,800 bidirectional miles) of arterial roadway and 377 centerline miles of limited-access highway—over 10% of all of the roadway miles in the region. This section describes the variables that are monitored on the region's roadways and presents the latest data available.

Methods for Measuring Highway Performance

The CMP identifies congestion on monitored roadway segments by examining a combination of the following travel-time-based measures: average observed travel speed, speed index, and delay. These performance measures are calculated from travel time data collected at peak commute times in typical traffic conditions. Some of the information below has already been included in the description of performance measures above and additional information is provided here to shed light on the way data are collected and processed.

Average Observed Travel Speed

Travel speed is a typical measure of performance for a roadway segment. The level of service (LOS) for a roadway or highway segment is determined using average-speed data.

Travel Speed Index

The travel speed index is a ratio that is calculated by dividing a roadway segment's average observed travel speed by the posted speed limit for that roadway segment. For example, if the speed limit is 50 miles per hour and the average observed travel speed is 40 miles per hour, the speed index is 0.80.

Delay

For purposes of CMP monitoring, delay is defined as the time a vehicle's travel speed is less than 5 mph on a roadway segment (including the time the vehicle is stopped), as long as the speed has been less than 5 mph for at least three consecutive seconds. The observed delay is closely related to "control delay" (for arterial roadways), which is the delay that occurs when a vehicle moves forward in a queue, a slow stop-and-go process. Congestion is defined as traffic conditions that involve an average delay of 55 seconds or more on arterial roadways.

Travel Times and Speeds

Travel time data are collected using a “floating car,” which is a probe vehicle that travels with the flow of traffic. Each probe vehicle is equipped with a global positioning system (GPS) and with a data collection device (portable computer) that records travel times and distances at one-second intervals. For each roadway segment, a valid sample size of travel time runs is obtained in order to calculate a significant average peak-period measurement. A segment usually begins immediately after a significant intersection and ends immediately after the next significant intersection.

The roadway monitoring captures typical traffic conditions during commute times. Roadways are monitored during weekday morning and evening peak commute periods—arterial roadways primarily between 6:30 AM and 9:30 AM and between 3:00 PM and 6:30 PM, and limited access highways, including HOV lanes, between 6:00 AM and 10:00 AM and between 3:00 PM and 7:00 PM. Note that peak periods do not necessarily represent the absolutely worst traffic conditions which actually occur during the peak hours. Monitoring does not occur on weekends, Monday mornings, or Friday evenings; nor does monitoring occur during the peak period preceding, during, or following a local, state, or national holiday. Monitoring is conducted during the public school year, in the spring and fall.

The CMP staff is currently investigating the possibility of acquiring travel speed data through methods other than the floating-car method. Crowd-sourced data from smart phones, GPS-enabled vehicles, and other real-time sources may prove to be more accurate and cost-effective than the current method.

Observed Travel Speeds

Limited-Access Highways

AM Peak Period

In the AM peak period, most of the slower speeds occur close to the urban core of the Boston region. In this area, almost all of the limited-access highways experience a slowdown, to some degree, in both directions. There are also some slower speeds on some of the limited-access highways leading to the urban core between I-95 and I-495. The highways that experience a slowdown of travel speeds include I-93 north and south of Boston, and Route 1A. Route 2 experiences an extreme slowdown of travel speeds in both directions between I-495 and I-95. The AM travel speeds for expressways are shown in figure 4-1.

PM Peak Period

With the exception of I-93 north of Boston, all limited-access highways experience a slowdown in both directions in the urban core. There is some slowdown on I-95, especially along the southern portion of I-95 just north of its interchange with I-93 (in Canton), where it occurs in the northbound direction. On I-95 between I-93 and I-90, the slowdown occurs in the southbound direction. Areas of slowdown between I-495 and I-95 include those along Route 2, Route 3, and I-90. The PM travel speeds for expressways are shown in figure 4-2.

Arterial Roadways

AM Peak Period

In the urban core, a slowdown in travel speeds occurs in both directions in the AM peak period. The main slowdown occurs in arterials inside of I-95. Outside of I-95, slow travel speeds occur mainly at major intersections. The AM travel speeds for arterial roadways are displayed in figures 4-3 and 4-5.

PM Peak Period

Near the urban core, the travel speeds in the PM peak period are slower than the AM peak-period travel speeds. The PM travel speeds are usually slow in all travel directions. The lowest PM travel speeds occur mostly inside of I-95. The PM travel speeds for arterial roadways are displayed in figures 4-4 and 4-6.

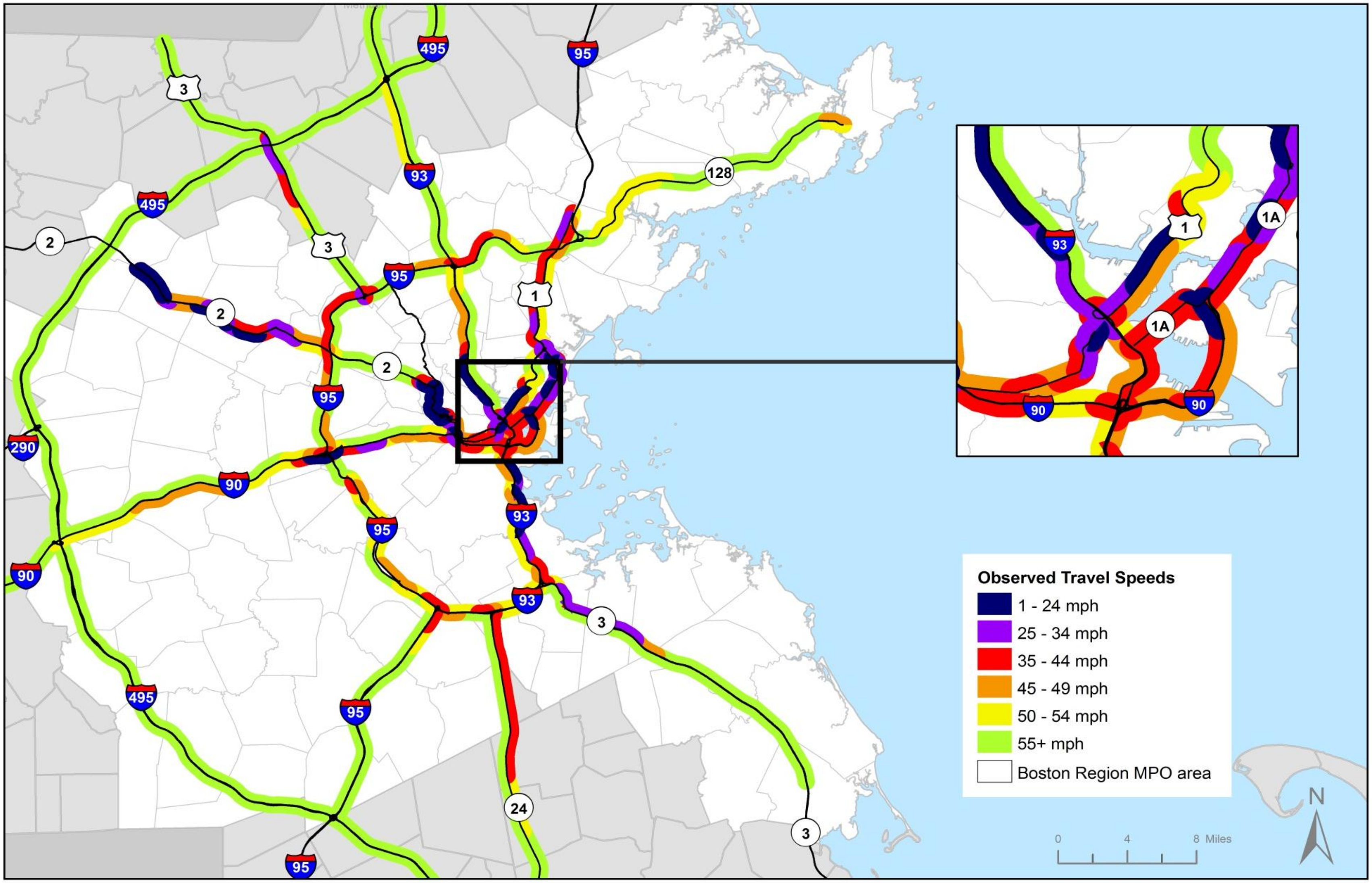

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FIGURE 4-1
Travel Speeds for Expressways:
AM Peak Period, 2004-07

Congestion Management Process

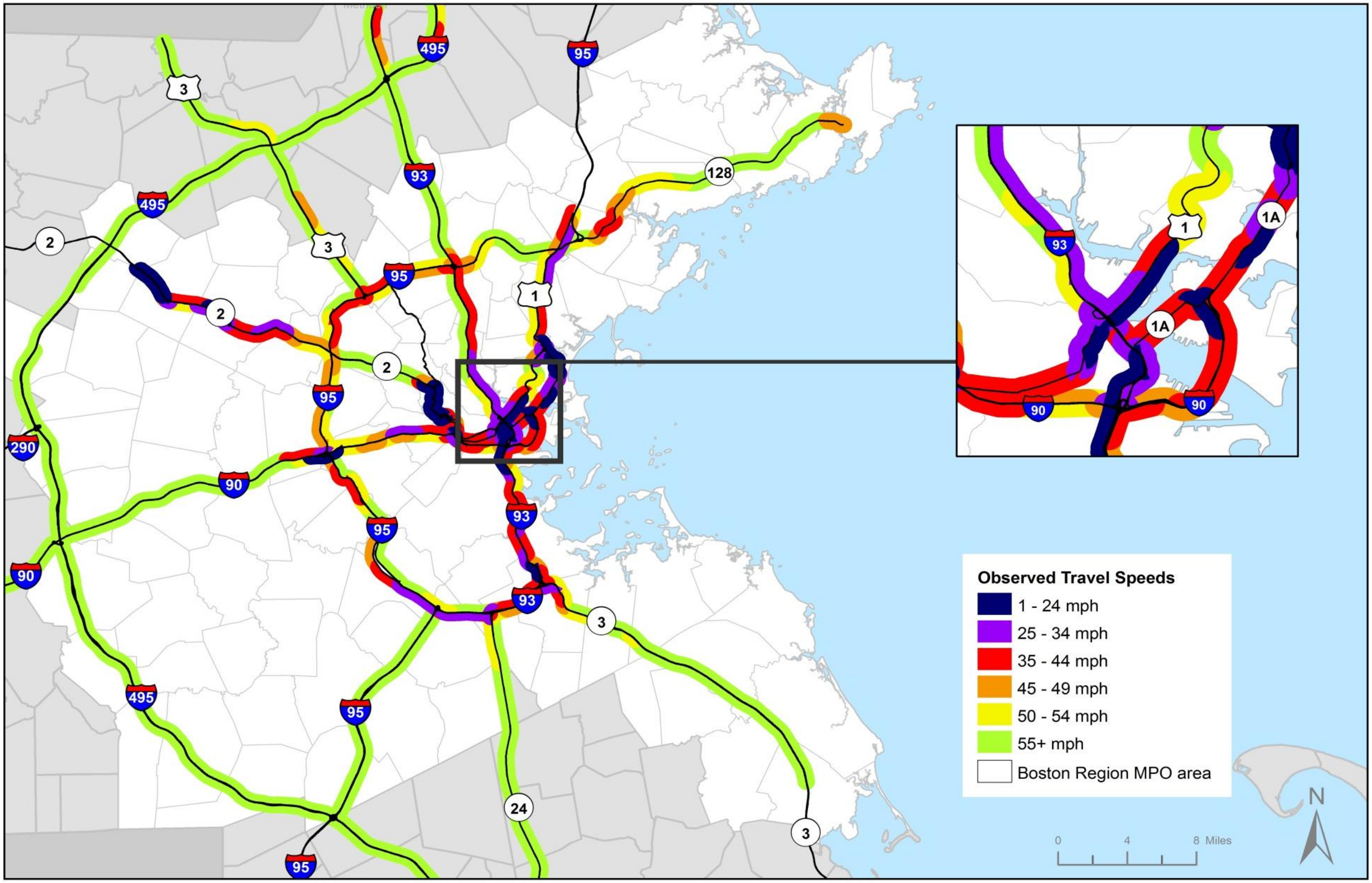

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FIGURE 4-2
Travel Speeds for Expressways:
PM Peak Period, 2004-07

Congestion Management Process

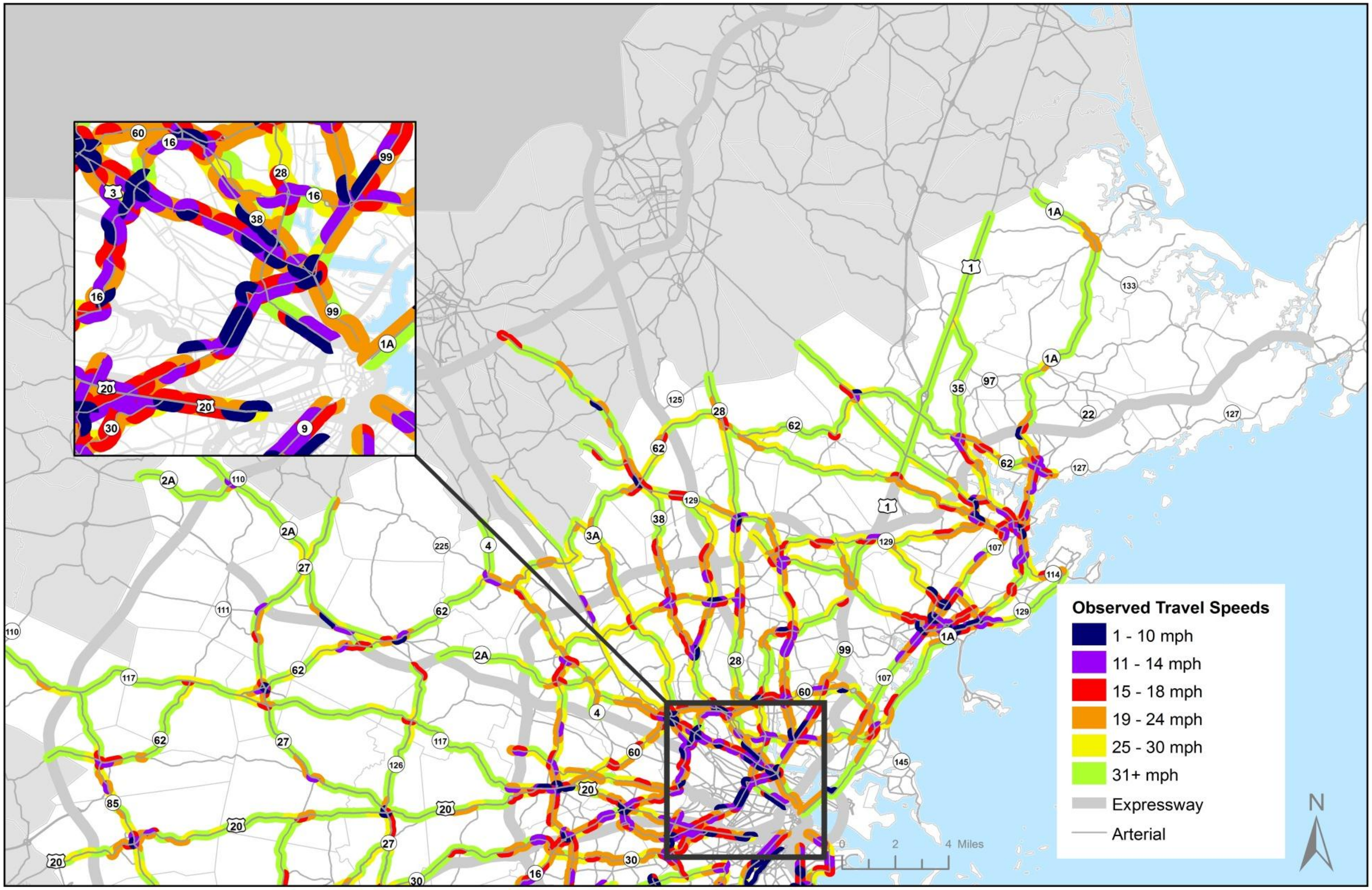

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FIGURE 4-3
Travel Speeds for Arterials: Northern Half of MPO Area,
AM Peak Period, 2001-08

Congestion Management Process

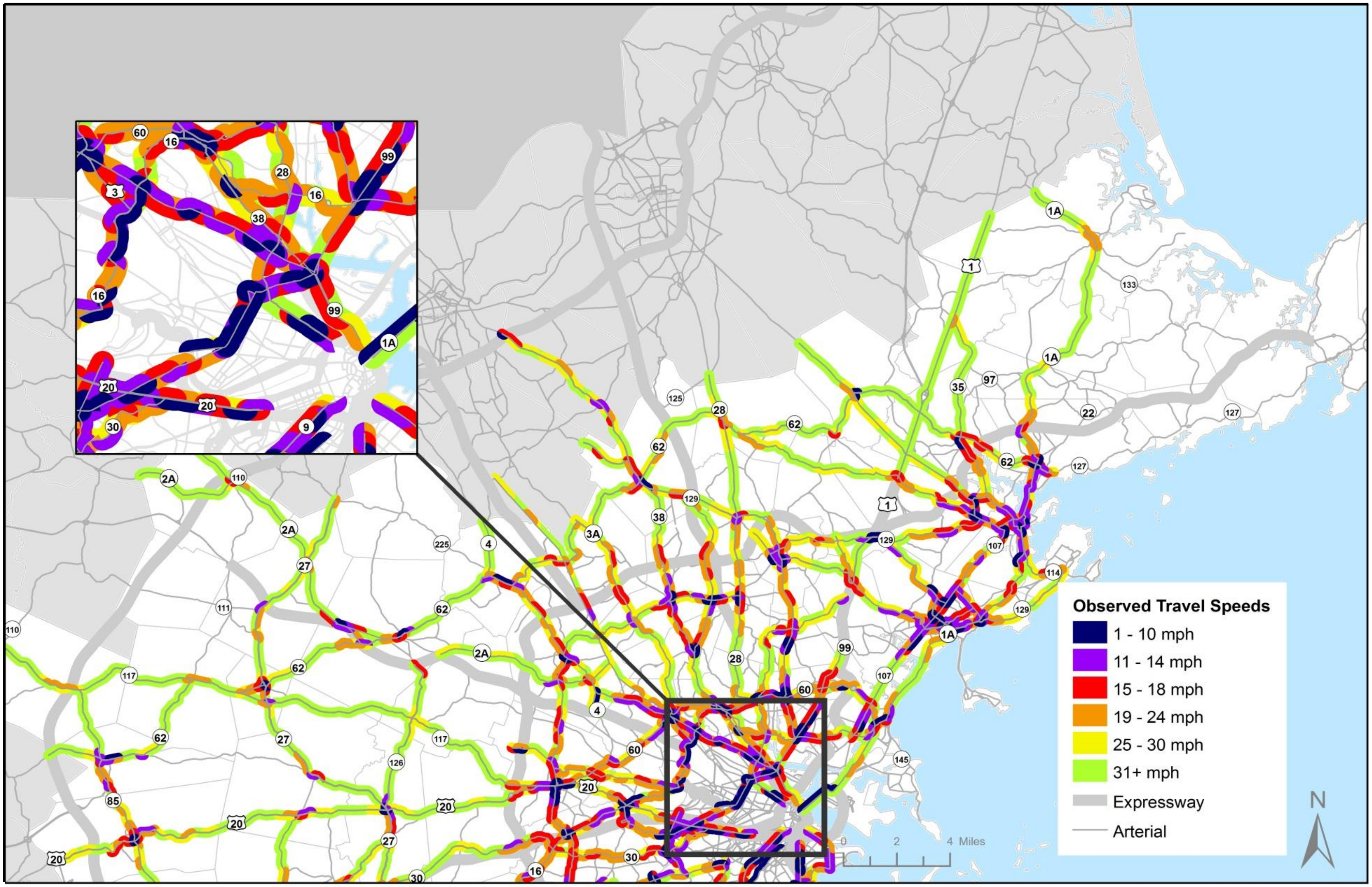

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FIGURE 4-4
Travel Speeds for Arterials: Northern Half of MPO Area,
PM Peak Period, 2001-08

Congestion
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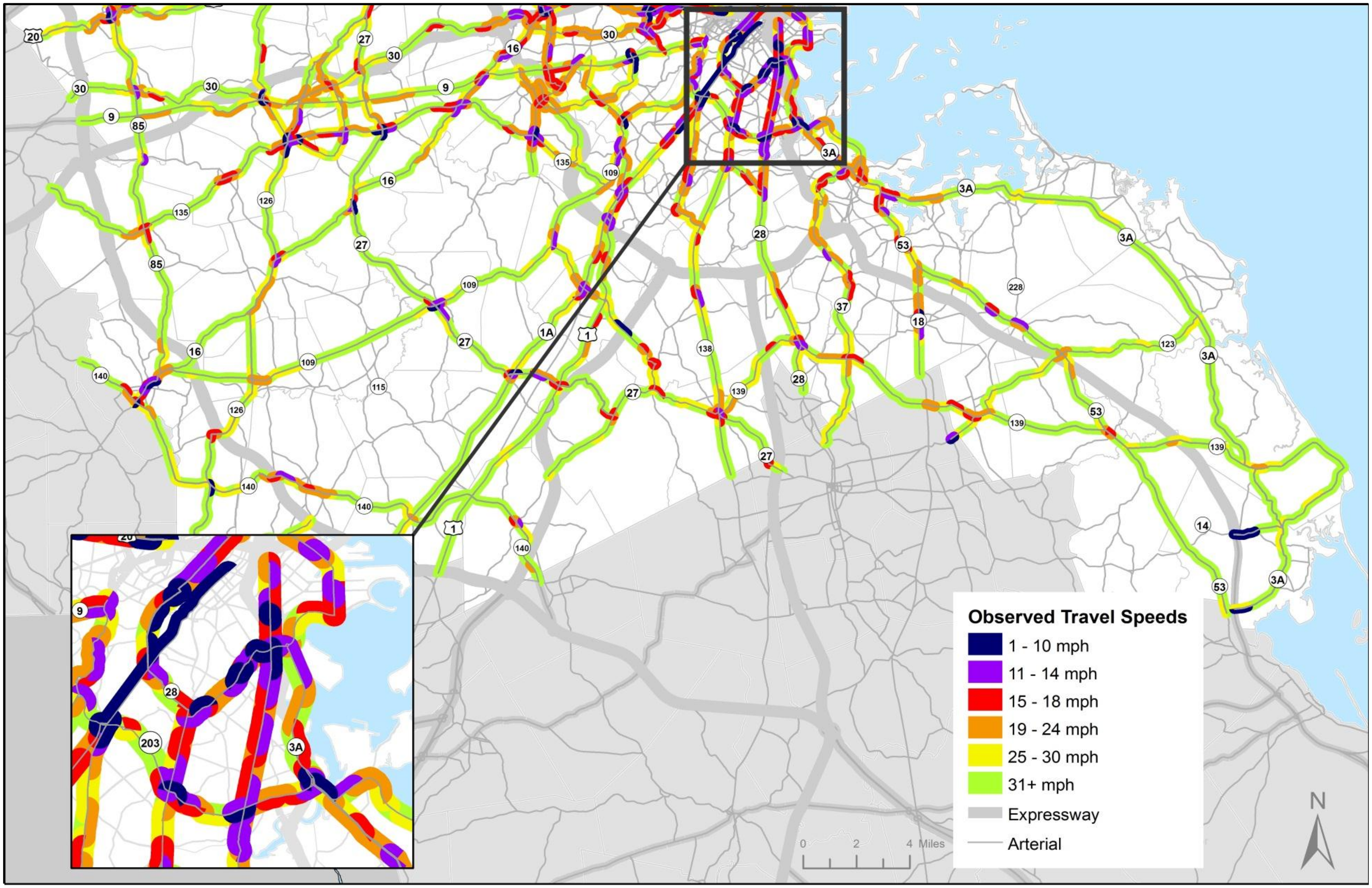

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FIGURE 4-5
Travel Speeds for Arterials: Southern Half of MPO Area, AM Peak Period, 2001-08

Congestion Management Process

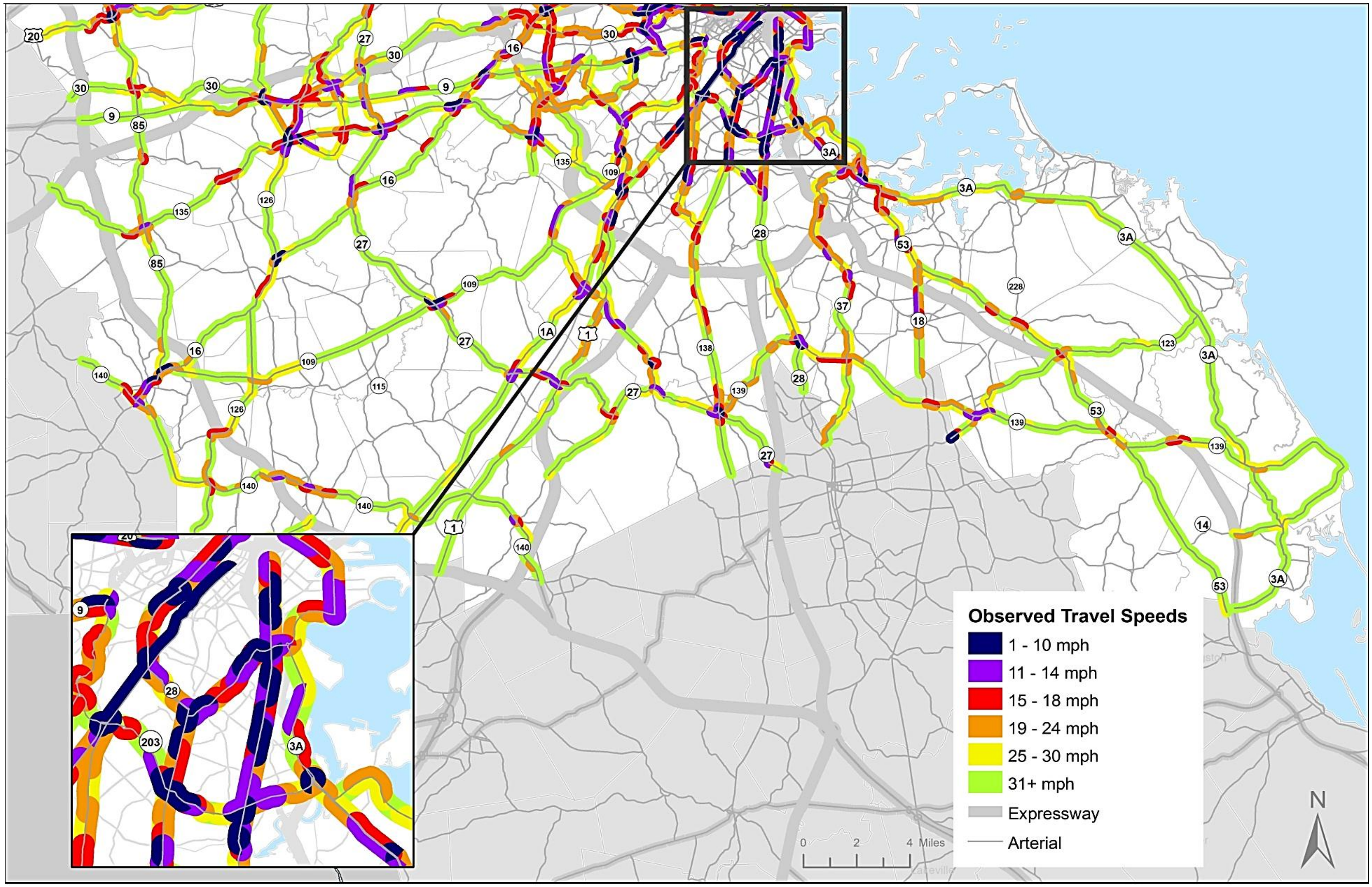

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FIGURE 4-6
Travel Speeds for Arterials: Southern Half of MPO Area,
PM Peak Period, 2001-08

Congestion Management Process

Speed Index

Limited-Access Highways

AM Peak Period

Most of the low speed indexes occur in the urban core. The limited-access highways outside of I-95 that have congestion, as indicated by speed index, are Route 3 northbound, Route 24 northbound, Route 2 in both directions, and I-90 eastbound. The AM speed indexes for expressways are displayed in Figure 4-7.

PM Peak Period

The speed indexes overall are slightly higher in the PM peak period, indicating less congestion. The main roadways that are congested are the Southeast Expressway (I-93) southbound, I-90 westbound, I-93 north of Boston, Route 1 northbound, and Route 2. The PM speed indexes for expressways are displayed in Figure 4-8.

Arterial Roadways

AM Peak Period

The speed indexes indicate that there is a lot of congestion in the urban core, with nearly all of the arterials in Boston having a speed index of less than 0.70. The speed indexes generally increase farther away from the urban core. Most of the low speed indexes that are located outside of I-95 occur on circumferential arterials. The AM speed indexes for arterial roadways are displayed in Figures 4-9 and 4-11.

PM Peak Period

During the PM peak period, most arterials throughout the MPO region, including those in the urban core, experience significant congestion, with a very low speed index. For both the PM and peak periods, most of the low speed indexes occur inside of I-95 or along circumferential arterials. The PM speed indexes for arterial roadways are displayed in Figures 4-10 and 4-12.

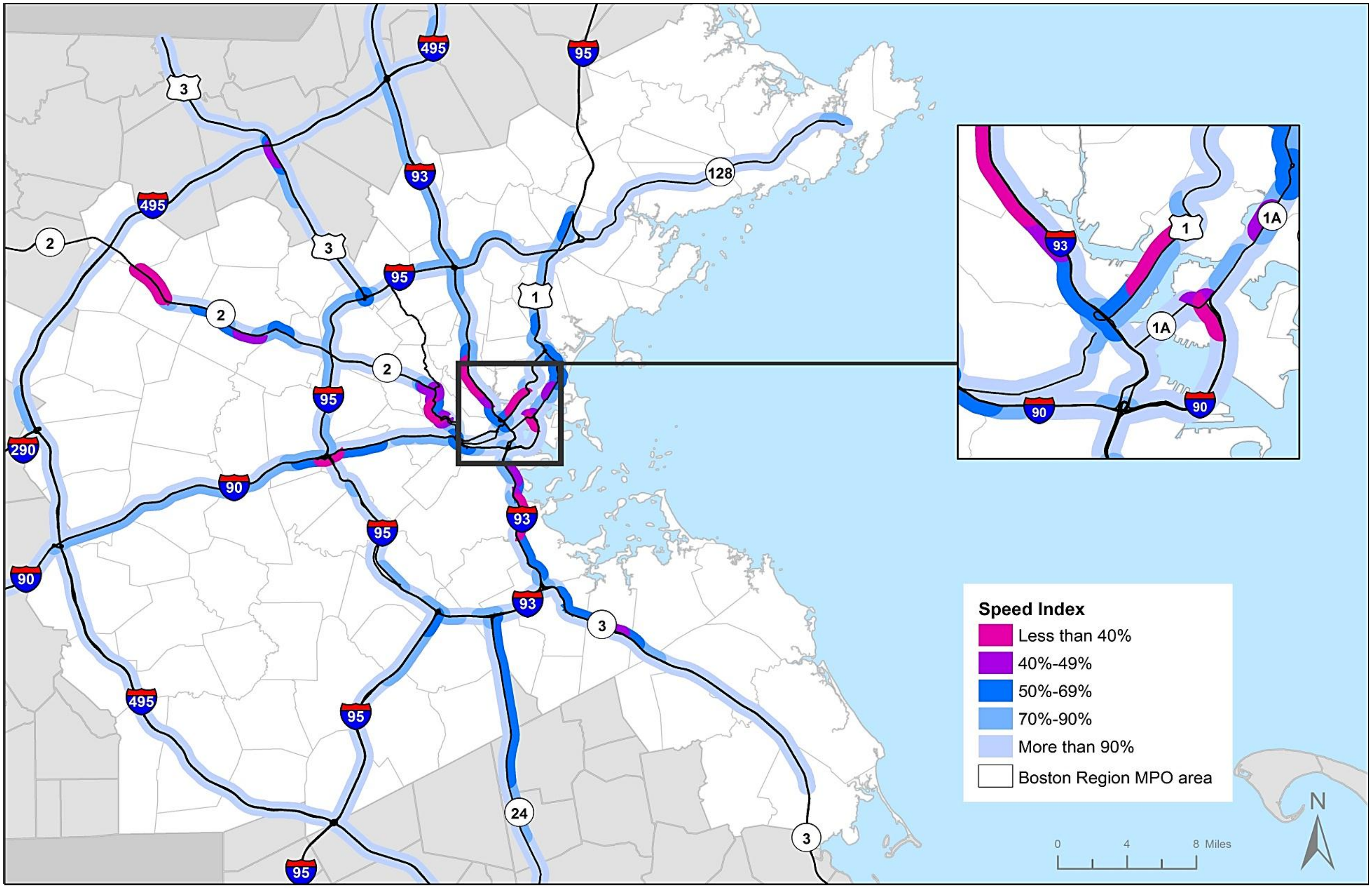

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FIGURE 4-7
Speed Indexes for Expressways:
AM Peak Period, 2004-07

Congestion Management Process

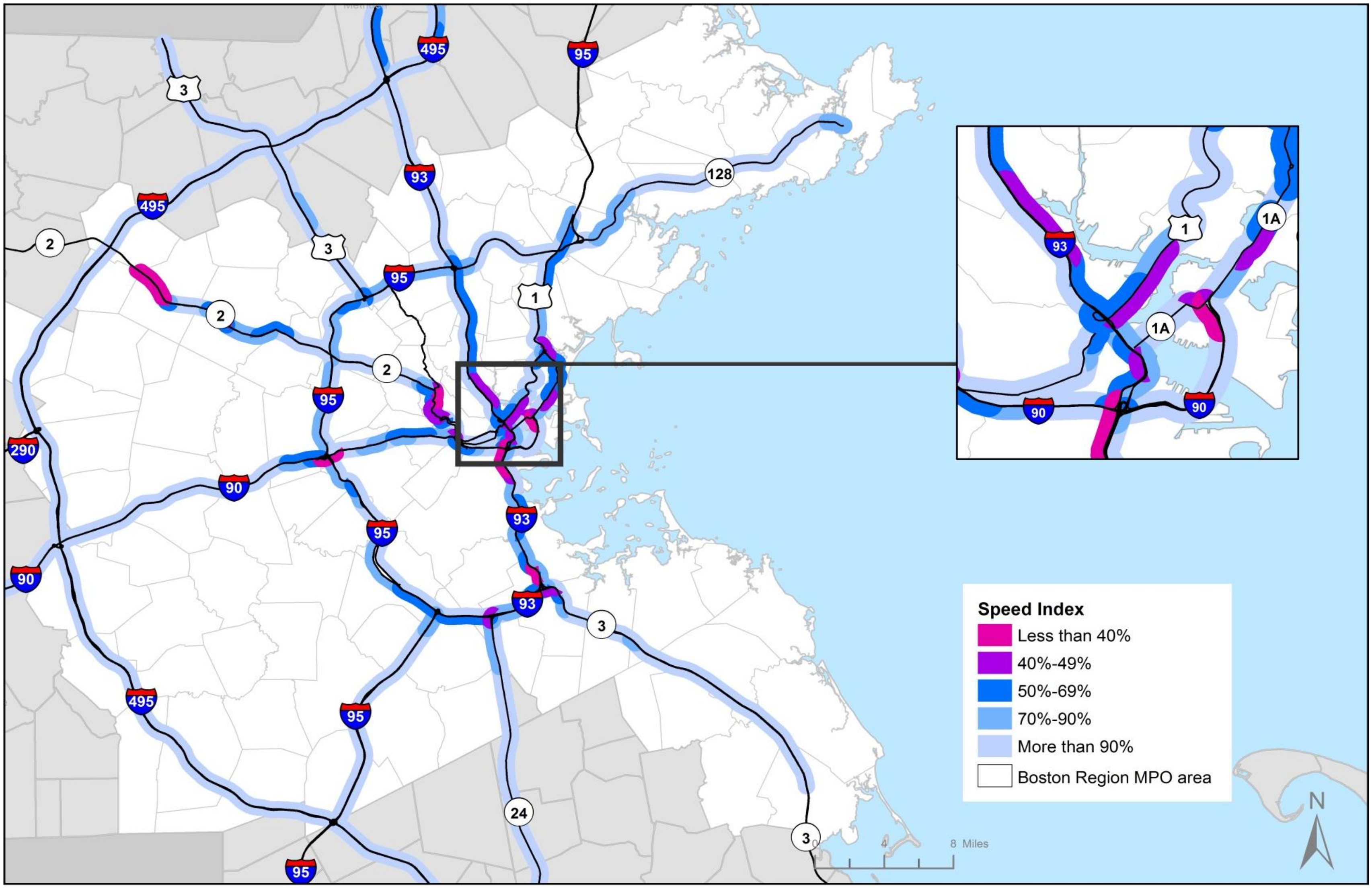

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FIGURE 4-8
Speed Indexes for Expressways:
PM Peak Period, 2004-07

Congestion Management Process

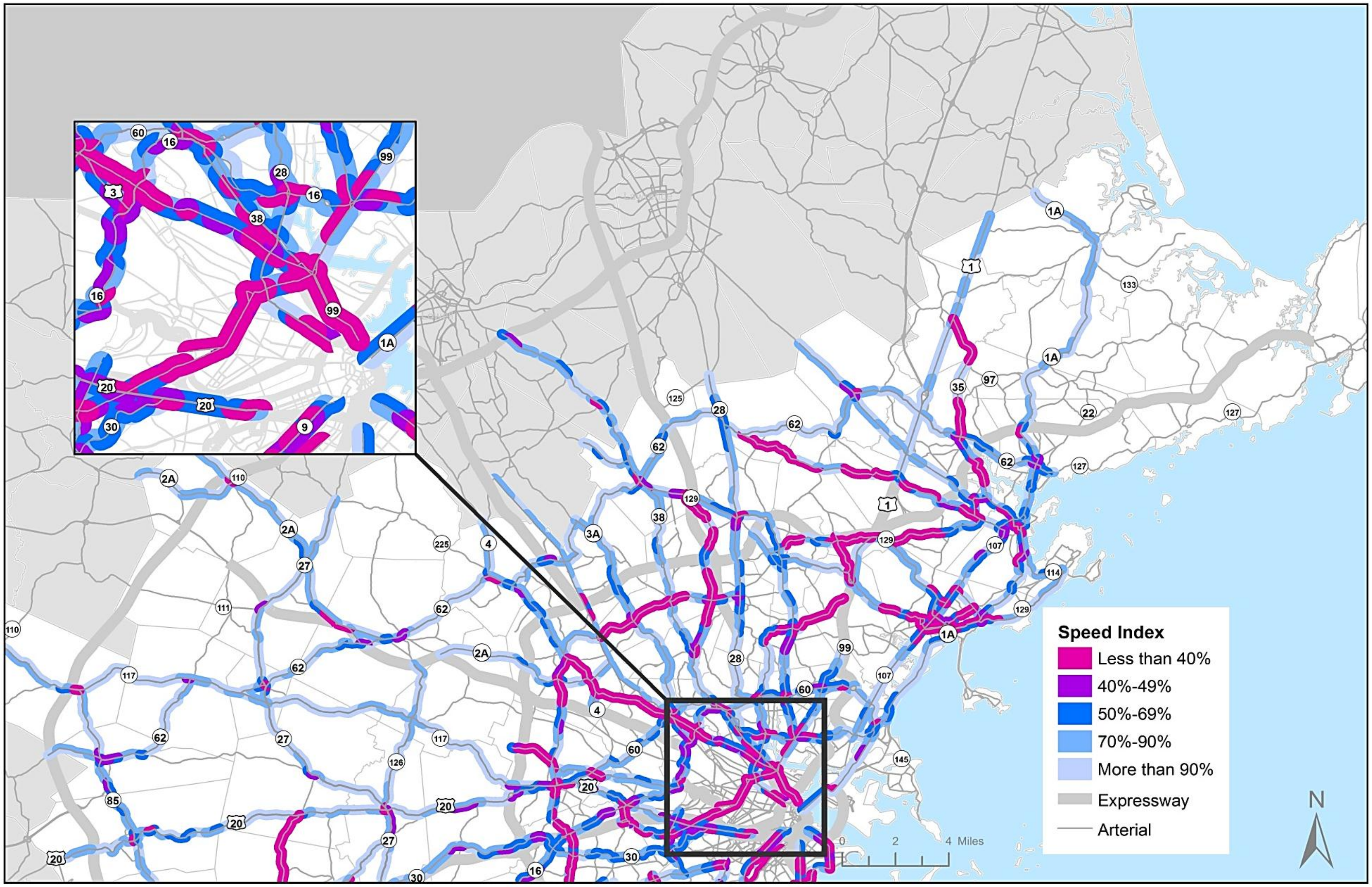

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FIGURE 4-9
Speed Indexes for Arterials: Northern Half of MPO Area,
AM Peak Period, 2001-08

Congestion Management Process

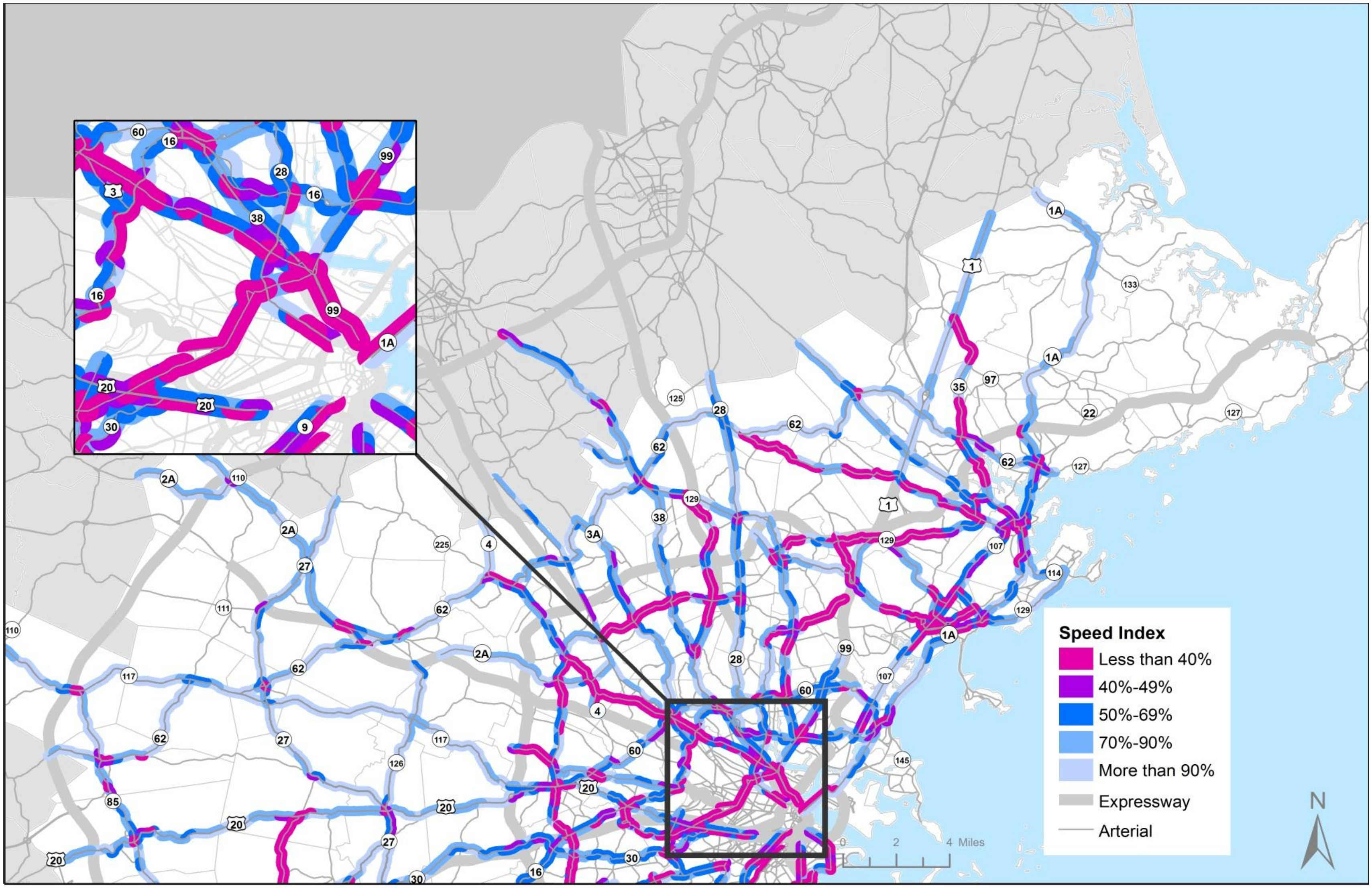

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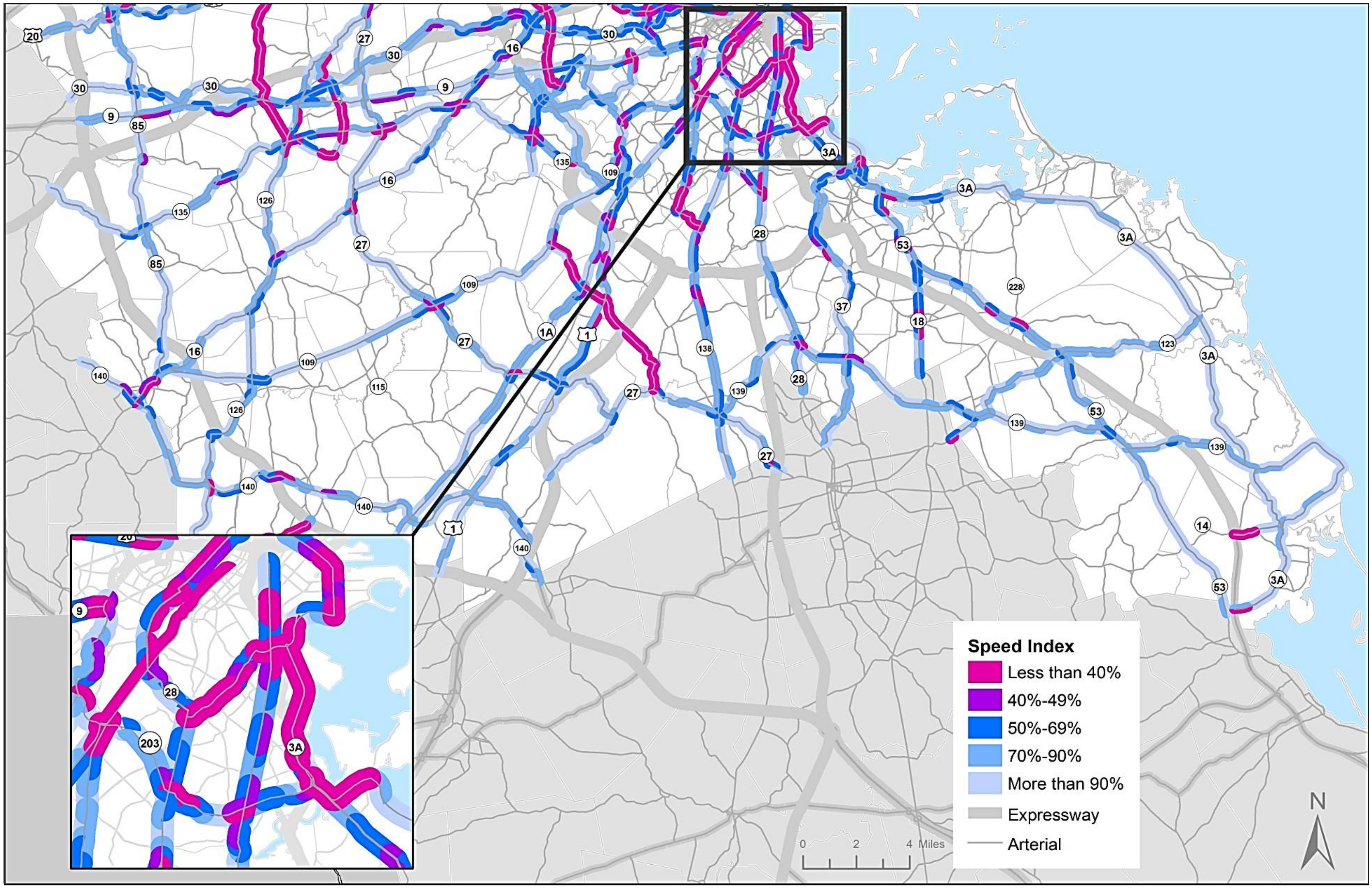
FIGURE 4-10
Speed Indexes for Arterials: Northern Half of MPO Area,
PM Peak Period, 2001-08

Congestion Management Process



BOSTON REGION MPO

FIGURE 4-11
Speed Indexes for Arterials: Southern Half of MPO Area, AM Peak Period, 2001-08

Congestion Management Process

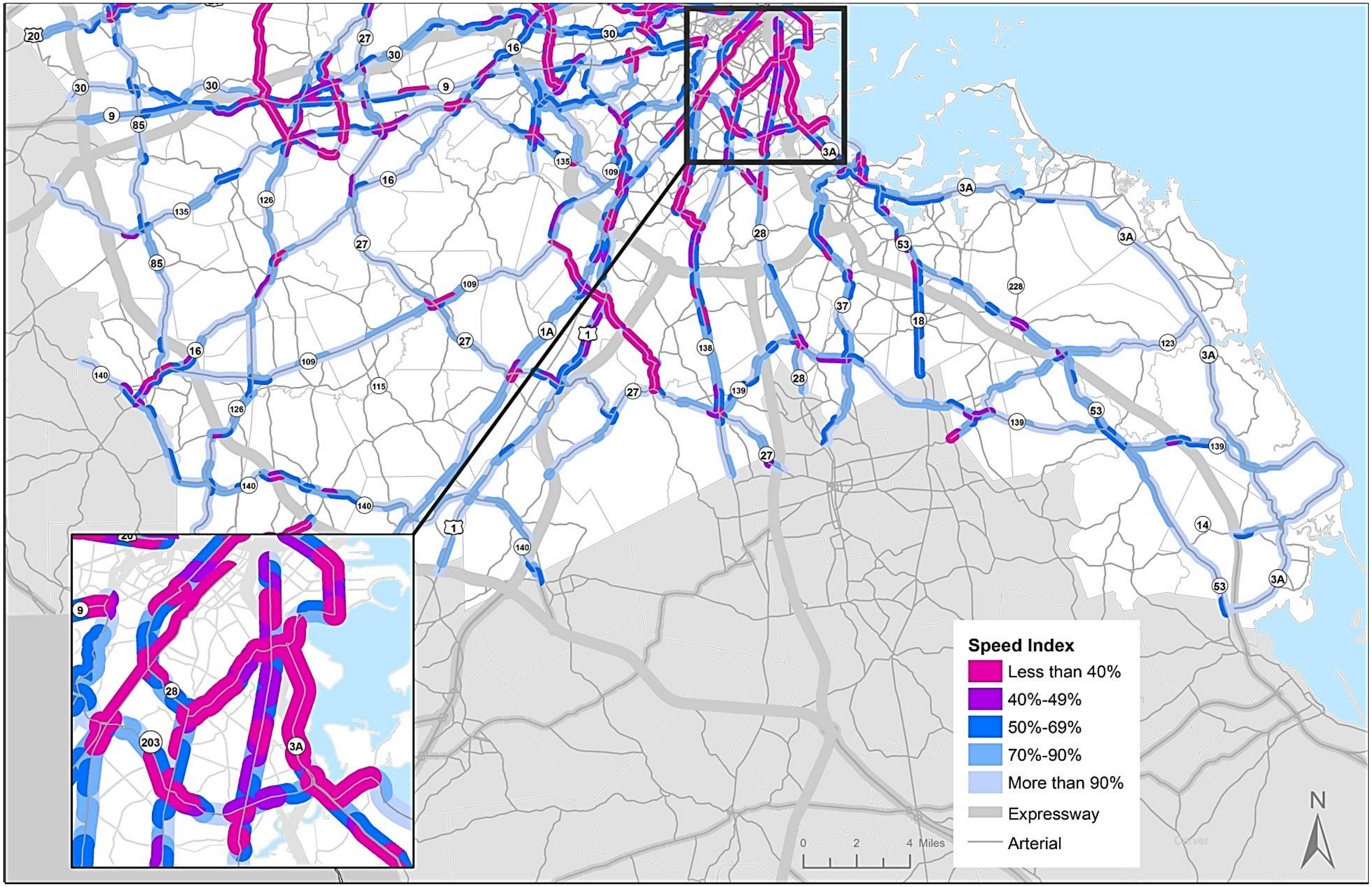


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FIGURE 4-12
Speed Indexes for Arterials: Southern Half of MPO Area,
PM Peak Period, 2001-08

Congestion Management Process

Congested Hours

An important relationship to acknowledge is between the traffic volumes of a roadway and the amount of congested hours a roadway experiences in a given day. The following maps illustrate this relationship by displaying the change in congestion between the late 1980s and the years 2005–08. The following maps show the AM and PM peak-period hours of congestion and traffic volumes for the Boston region in the late 1980s and in the period between 2005 and 2008 for the region's limited-access roadways. Overall, in the late1980s, most roadway congestion was located close to the urban core. Traffic volumes in the late 1980s were at or near capacity for at least 1.5 to 3.0 hours during each peak period for most of the circumferential portion of Route 128, and parts of Route 1 North, Route 3 North and South, and I-93 North to its interchange with Route 128. Traffic conditions were already worsening on the Central Artery and the Southeast Expressway by the late 1980s, with some sections experiencing traffic volumes at or near capacity for 3.0–4.5 hours during each daily peak period of travel.

Over the course of the 20-year period, traffic conditions have continued to deteriorate. Much of I-95, the Southeast Expressway, and the Central Artery tunnel (Thomas P. "Tip" O'Neill Tunnel) routinely experienced 3.0 to 4.5 hours a day of volumes at or near capacity during each of the daily peak periods of travel, with some roadway sections experiencing more than 4.5 congested hours twice a day. Congestion on I-93 downtown was initially reduced in the early years following the completion of the CA/T project in 2005. Traffic congestion has also been extending into the outer reaches of the Boston region, as almost the entire northern half of I-495 experiences some traffic congestion during the daily peak periods of travel. Parts of Route 3 North and I-93 are also experiencing 1.5 to 3.0 hours of traffic volumes at or near capacity. Significant congestion is also beginning to be experienced on certain express-highway segments in the Worcester area (which is outside the Boston Region MPO area). This increase in traffic congestion in the outer reaches of the MPO region is due to the increase of circumferential commutes in the region caused by the emergence of job centers in those areas. Figures 4-13 through 4-16 display the congested hours on the regions' expressways in the late 1980s and in 2005–08.

Summary of Roadway Monitoring

Overall, the majority of the congestion in this region occurs inside of I-95. There are, however, some suburban areas that experience extreme congestion as well. Many limited-access expressways are congested in the peak-period direction of travel regardless of where the roadway is located in the region. There is also some congestion on many of the circumferential routes in the MPO region. The causes of these patterns could be that while there are many employment centers located in the suburbs, the region still has a large central business district in Boston that continues to attract jobs and produce congestion.

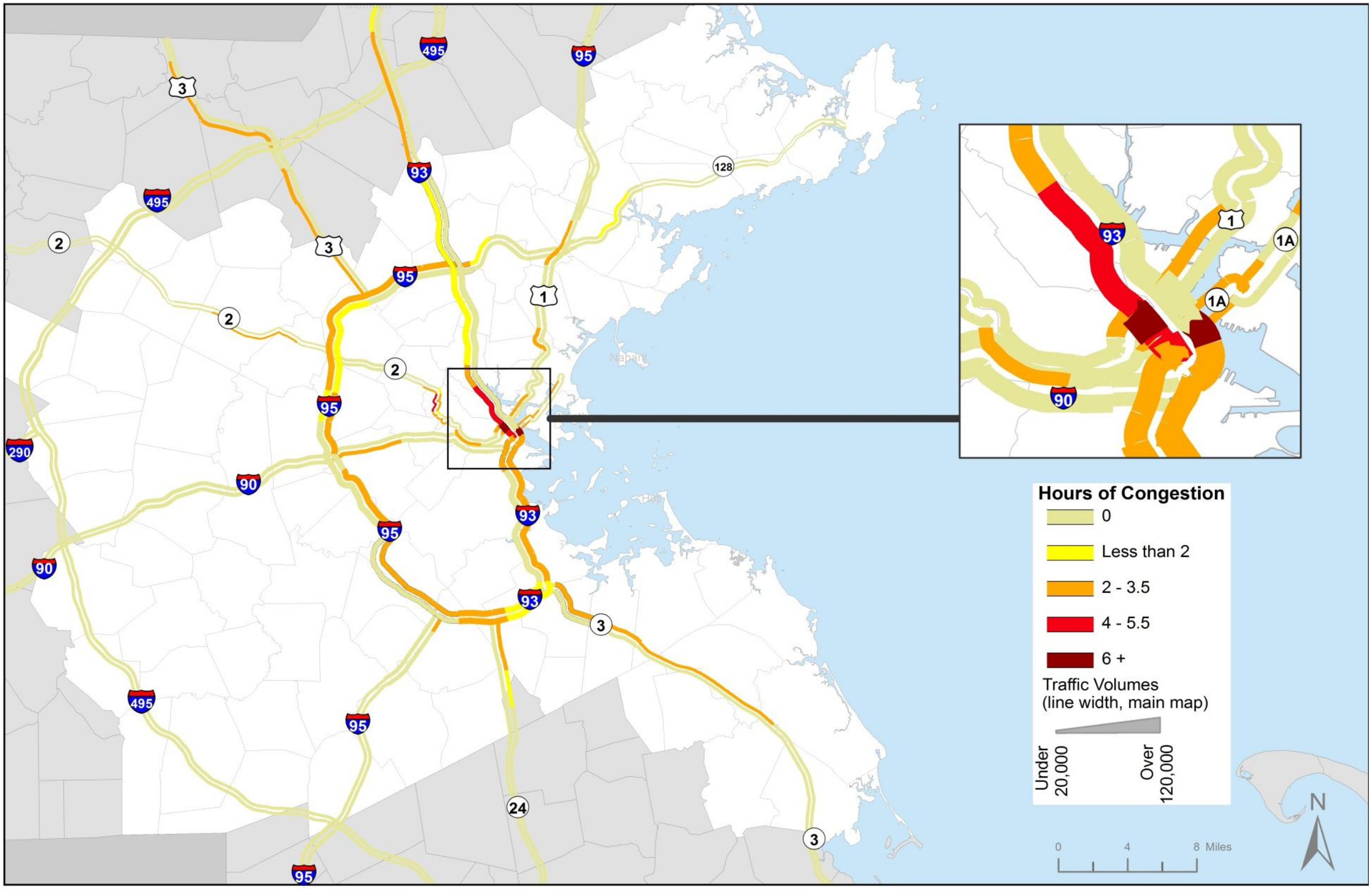

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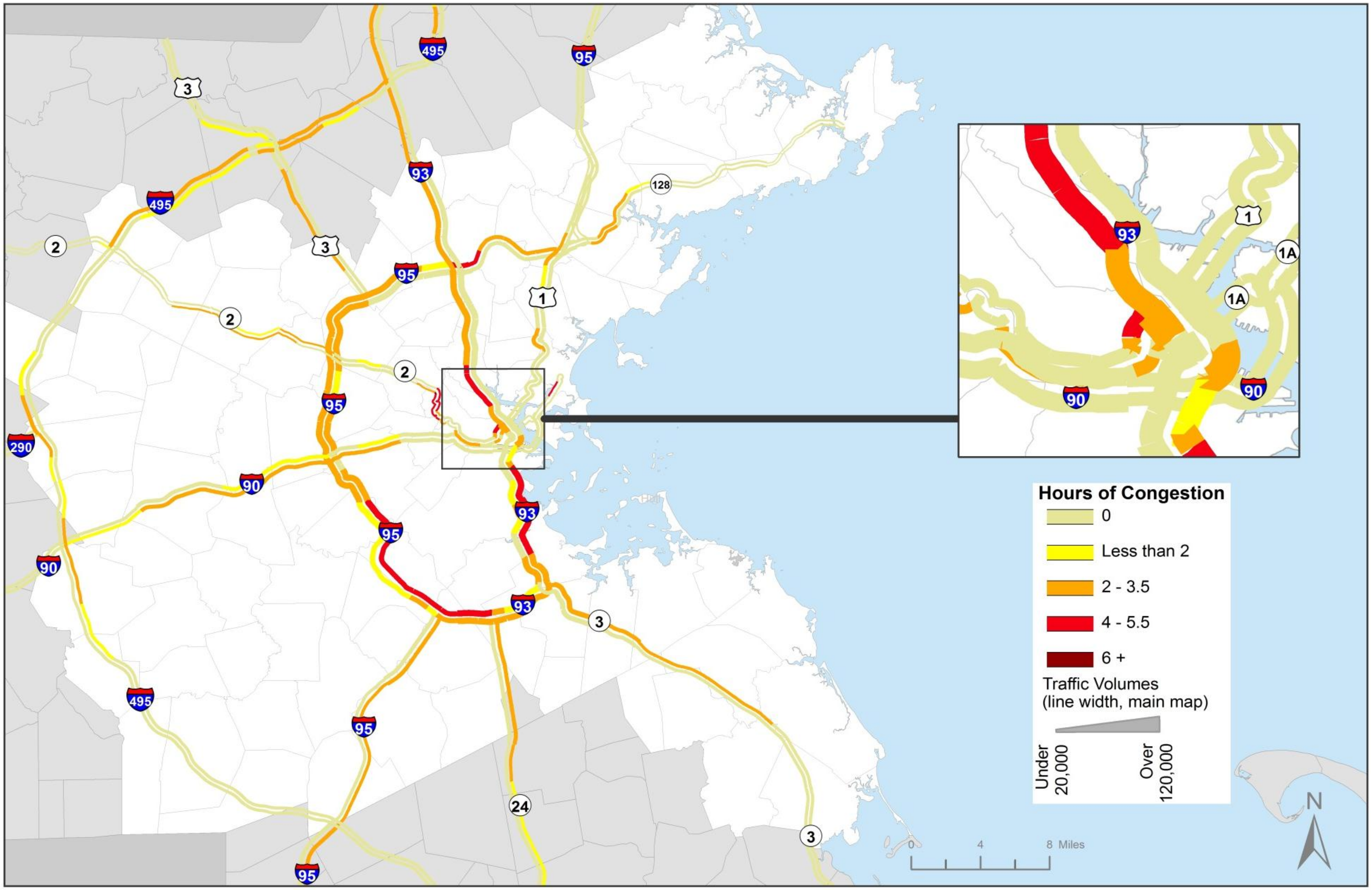
FIGURE 4-13
Boston Region Expressways: AM Peak-Period Hours of Congestion
Late 1980s

Congestion Management Process



BOSTON REGION MPO	FIGURE 4-14 Boston Region Expressways: AM Peak-Period Hours of Congestion 2005-08	*Congestion Management Process*

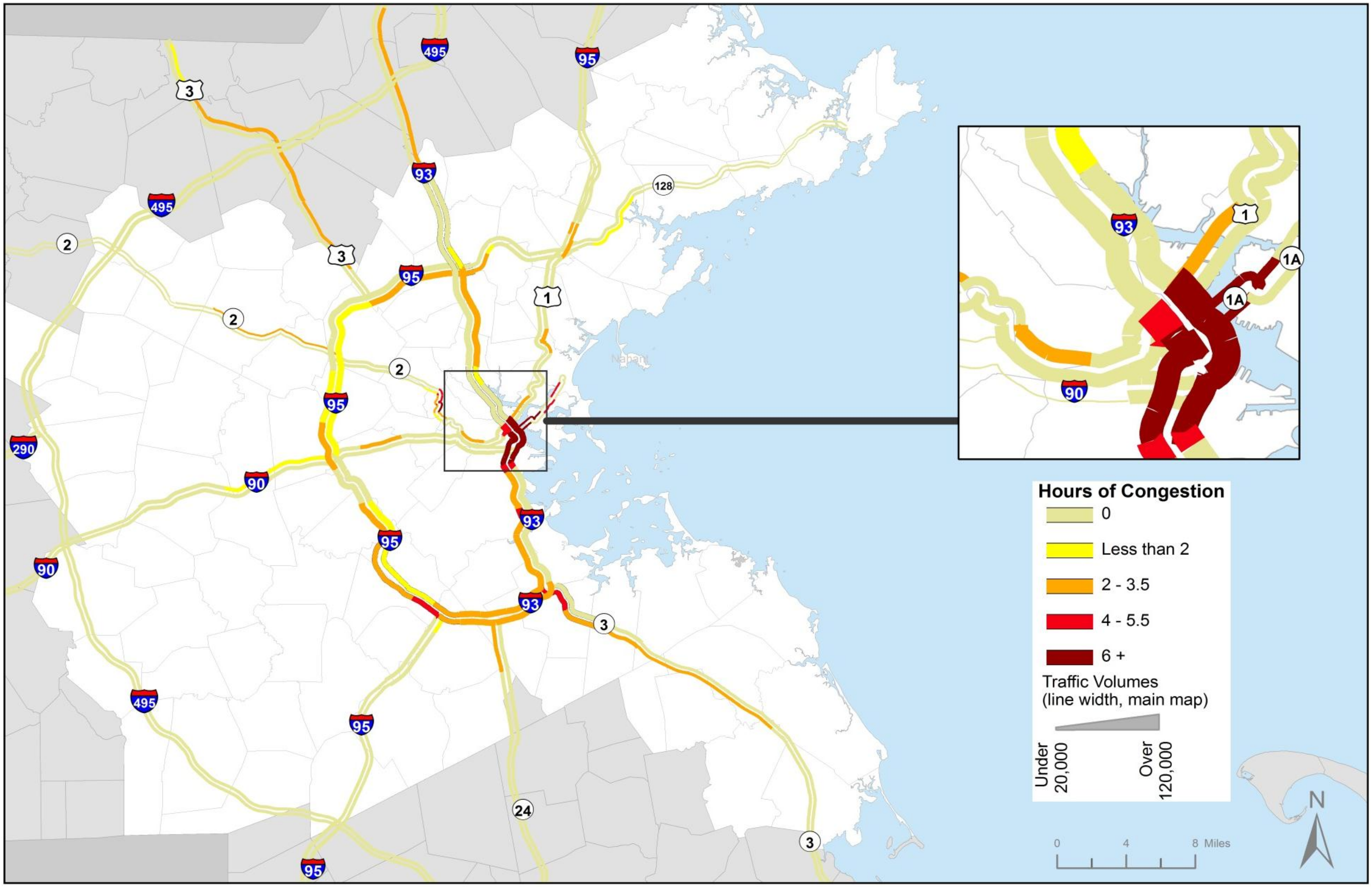


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FIGURE 4-15
PM Peak-Period Hours of Congestion
Boston Region Expressway: Late 1980s

Congestion Management Process

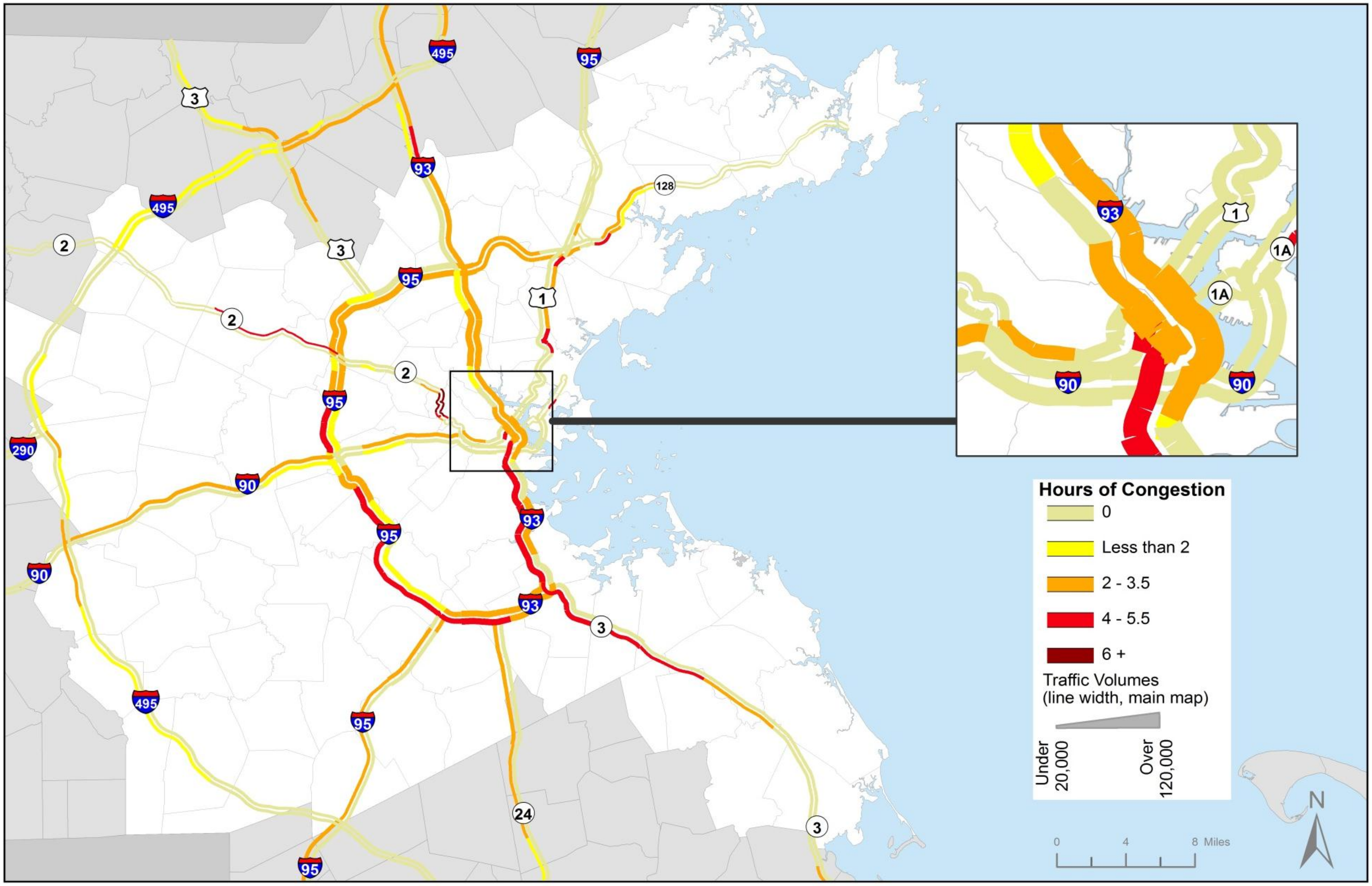

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FIGURE 4-16
PM Peak-Period Hours of Congestion
Boston Region Expressways: 2005-08

Congestion Management Process

INTERSECTION MONITORING

Since 2000, CMP staff has monitored the performance of over 1,500 intersections in the Boston region. Approximately 300 intersections were monitored through detailed evaluations that included staff site visits, data collection, and subsequent analysis and assessment, or through the gathering of data from existing MPO reports. These intersections are displayed in Figure 4-17. The rest were monitored for approach delay data gathered during travel time runs and by analyzing safety statistics. Information about all of these intersections can be found in an interactive database hosted on the CMP webpages on the Boston Region MPO's website.

The vast majority of intersections selected for performance monitoring are on regionally significant arterial roadways. They were identified as problem locations through travel time monitoring; from safety analyses for vehicle, pedestrian, and bicycle modes; and from outside data sources in relation to conceptual and pre-TIP projects. The database contains, at a minimum, information on peak-hour approach delays on the main road going through each intersection, as well as traffic volumes, crash data, transit routes, and bicycle and pedestrian facilities. In the CMP, delay is defined as the time, over three seconds, for which a vehicle travels less than 5 mph on a segment of roadway that approaches a signalized intersection. Intersections analyzed in more detail include level-of-service analysis, field observations, and recommendations for improvements and for further study.

As a component of the Congestion Management Process, information from intersection performance monitoring is used to inform decisions about projects funded in the Transportation Improvement Program (TIP). In addition, intersection performance monitoring supports the Long-Range Transportation Plan (LRTP) by providing data for the needs assessment.

Interactive Database for Intersections

The CMP interactive database shows monitored intersections using Google maps for the 1,500 CMP-monitored intersections. The data in this interactive database come from several different sources, including "speed runs" (travel-time data collection), turning-movement counts, and crash data. Most of the data on the intersections in the database come from the speed runs. For approximately 300 intersections, there are more detailed data available about the level of service and turning-count movements of the intersection. Some intersections also display the crash data and crash rate.

Survey to Select Intersections for Low-Cost Improvements

In the summer of 2010, CMP staff solicited feedback from city and town staff regarding intersection locations in their municipalities where they thought that problems could be corrected with low-cost improvements.

Initial screening excluded intersections that were:

- Previously monitored
- Included in programmed TIP projects
- Complicated (intersections that were at interchanges or had more than four legs)

Equivalent Property Damage Only (EPDO) is a weighted scoring system that MassDOT uses to rank intersections by crash severity. This measure enables the intersections to be ranked by the severity of crashes, rather than the number of crashes.

The weighting system is as follows;

- Property damage only = 1 per crash
- Personal injury = 5 per injury
- Fatality=10 per fatality

The list of remaining intersections was sorted to produce, for each city or town, the five intersections with the highest EPDO ratings for crashes. This resulted in a list of 505 intersections, which were posted on the MPO's website by municipality for review and feedback from the public and staff from the MPO's 101 cities and towns. In addition, CMP staff solicited from them recommendations for locations other than the five provided online for a given city or town. A total of 234 responses from 33 cities and towns was received.

This list was then sorted by the number of responses received and by the EPDO rating to produce a final list of 15 priority intersections, listed in Table 4-1. The priority intersections file is used by staff to select, in coordination with municipal officials and staff, the locations to be studied in detail as part of the MPO's program Safety and Operational Improvements for Selected Intersections. As part of the FFY 2011 UPWP study "Safety and Operations Analyses at Selected Intersections," the Arlington and Bedford intersections in the table were studied. The study included field reconnaissance, safety and traffic analysis, and short- and long-term recommendations for traffic management, safety, and bicycle and pedestrian accommodations.

TABLE 4-1
2010 CMP Survey: Priority Intersections

Town	Streets at Intersection	EPDO
Acton	Concord Road at Great Road	23
Arlington	Park Avenue Extension at Lowell Street (Downing Square)	25
Bedford	Brooksbie Road at The Great Road	32
Boston	Bynner Street/Willow Pond Road at Jamaicaway	78
Holliston	Hollis Street at Highland Street	21
Lexington	Bedford Street at Hill Street/Revere Street	38
Malden	Commercial Street at Medford Street	94
Medford	Harvard Street at Main Street	69
Medway	Main Street (Route 109) at Holliston Street	83
Sharon	Canton Street at North Main Street	25
Stoughton	Central Street at Canton Street	30
Waltham	Grant Street at Main Street	46
Watertown	Arsenal Street at Greenough Boulevard	91
Weston	Boston Post Road/Boston Post Road Bypass at Wellesley Street	75
Wrentham	Common Street at East Street	40

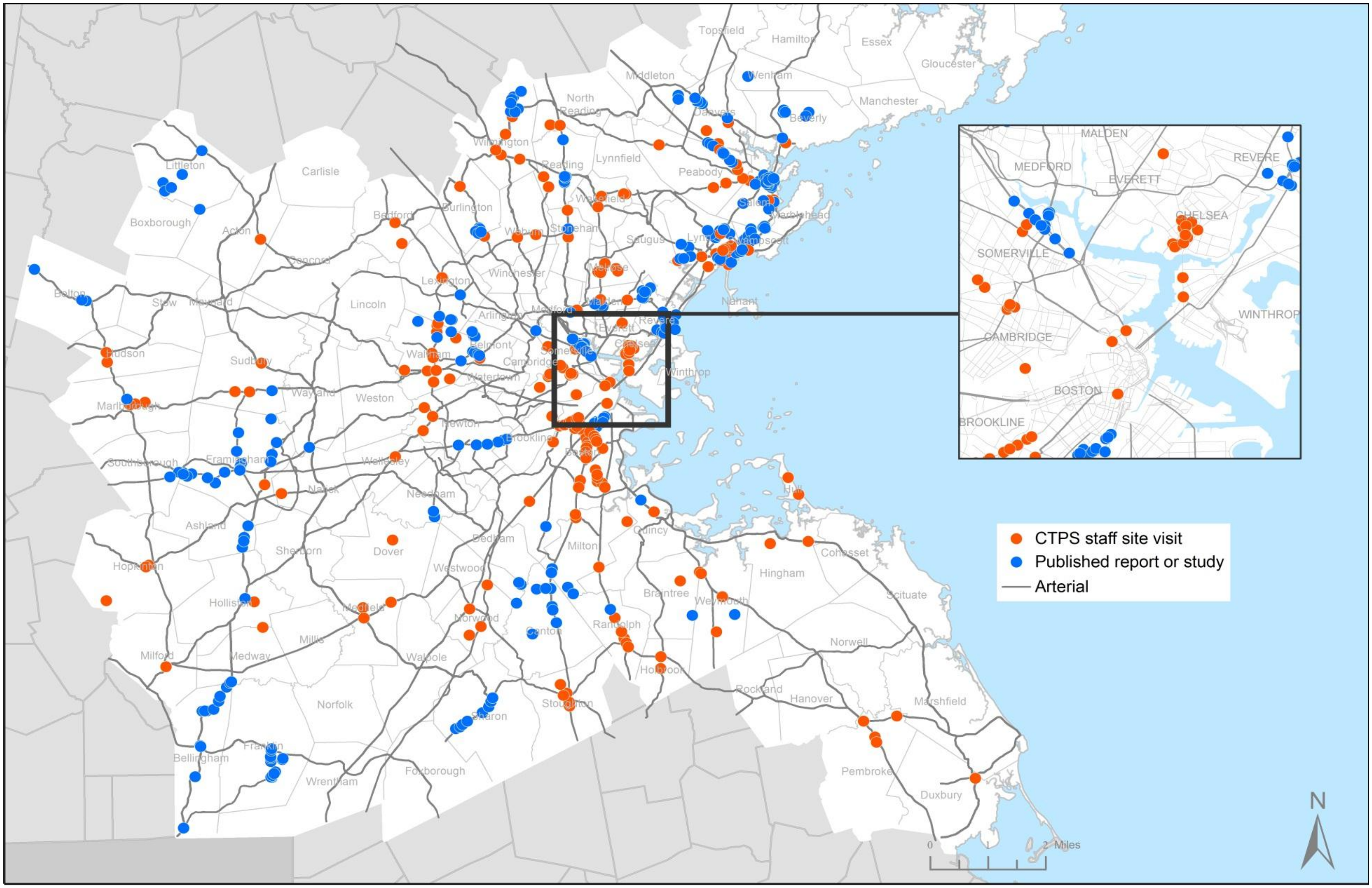

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FIGURE 4-17
CMP-Monitored Intersections
2004-11

Congestion Management Process

HIGH-OCCUPANCY-VEHICLE (HOV) LANES

Historical Background

I-93 North HOV Lane

In February 1974, a southbound high-occupancy-vehicle (HOV) lane was established on I-93 North. In response to ever-increasing queue lengths, this HOV lane was lengthened in August 1974, and then again in October 1979, when it stretched a total of 1.07 miles from the beginning of the I-93 double-deck elevated structure near Sullivan Square to a point 900 feet north of the merge of I-93 and Route 1. The lane was later extended farther, to a length of 2.0 miles, to run from a point just south of Mystic Avenue in Somerville to a point 0.12 mile north of the Route 1 merge in Charlestown. On March 5, 2005, it was extended by more than half a mile, from the lower deck onto the Leonard P. Zakim Bunker Hill Bridge. This extension coincided with the full opening of the southbound lanes of the bridge and the Central Artery tunnel, increasing the length of the lane to 2.6 miles.

When the I-93 North HOV lane was initially opened, it was made available to buses, to motorcycles, and to carpools and vanpools having at least three persons per vehicle. This entry criterion provided acceptable levels of usage in spite of the relatively small numbers of carpools, because the lane was available to all vehicles traveling from I-93 southbound to Route 1 North (including significant numbers of commuters traveling to downtown Boston via the Navy Yard off-ramp and Charlestown Bridge). When the Central Artery North Area project began in 1987, however, the ramp to Route 1 North was closed and vehicles could no longer travel directly from I- 93 southbound to Route 1 North using the HOV lane. The consequent case of “empty lane syndrome” ultimately led to the 1988 change of the HOV-lane entry requirement to the two-plus-persons criterion that has been retained to date. By 1992 the HOV lane was carrying about 1,100 vehicles during the AM peak hour, which was near its capacity, given the geometry of its merge with the general-purpose lanes at its southern end. Access from the HOV lane to the Leverett Circle Connector was cut off when the latter was completed in 1999. This reduced the volumes in the HOV lane, which are presently between 700 and 800 vehicles per peak hour.

I-93/Southeast Expressway HOV Lane

The I-93/Southeast Expressway HOV lane opened in 1995 as mitigation for the Central Artery project. Entry has been limited to carpools, vanpools, private vehicles meeting the occupancy criteria, motorcycles, and buses. This five-mile-long HOV lane has one terminus south of Columbia Road (Exit 15) and another located south of Furnace Brook Parkway (Exit 8) in Quincy, just north of the Braintree Split (Exit 7) and Route 3 (Exit 20). The occupancy requirement for the lane has changed over the years: initially the

entry rule was three or more occupants per vehicle; after that there was a sticker program (red and green) that allowed vehicles with two occupants to enter the lane on alternate days. This was later expanded to allow all vehicles with stickers to use the lane on all days. Presently, any vehicle with two or more occupants meets the entry requirement for the HOV lane. This change did not result in any negative effects to either the general-purpose or HOV lanes.[1] The Southeast Expressway HOV lane's original three-or-more occupancy rule resulted in maximum volumes of 375 and 400 vehicles per hour for the AM and PM peak periods, respectively. With the introduction of the two-person-occupancy sticker program in 1998, these volumes increased to a maximum of 550 and 525 vehicles per hour for the AM and PM peak periods, respectively. In February 1999, when the two-person-occupancy sticker program was expanded to all days, the maximum volumes increased to 825 vehicles per hour during the AM peak period and 550 during the PM peak period. In June 1999, when the HOV lane was opened to all vehicles with two or more occupants, with no sticker required, the lane use increased to 1,300 vehicles per hour during the AM peak hour and 1,000 during the PM peak hour. Presently, the volume in the HOV lane typically does not exceed 1,300–1,400 vehicles per hour either northbound during the AM peak hour or southbound during the PM peak period.

Data Collection Method

Data for each HOV lane that are collected quarterly by the MPO staff include passenger counts and travel times on both the HOV lane and the adjoining general-purpose lanes. Seasonal performance data are collected on the two HOV lanes as part of an ongoing, mandated monitoring program. Two separate data collection efforts take place: one collects travel times, and the other collects vehicle occupancies and traffic volumes.

Travel time data samples are obtained by using probe vehicles. During the hours of operation of the HOV lanes, these vehicles drive in both the I-93 general-purpose lanes adjacent to the HOV lane and the HOV lanes themselves, collecting travel speeds.

Vehicle-occupancy data are collected and reported on in the fall and spring and are used to measure and compare the numbers of person-trips in the general-purpose lanes and the HOV lanes. Data are obtained by observers using tally counting equipment.

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[1] Tom Lisco and Kate Wall, "Short-Term Speed and Travel Time Effects of the Change to a Two-Plus Occupancy Requirement for Use of the Southeast Expressway Carpool Lane," a memorandum prepared by the Central Transportation Planning Staff for Luisa Paiewonsky, then Director of MassHighway's Bureau of Transportation Planning and Development, June 9, 1999.

For the following facilities, travel time data are collected between 6:00 AM and 10:00 AM:

- I-93 North HOV lane, southbound
- I-93 North general-purpose lanes, southbound
- Southeast Expressway HOV lane, northbound
- Southeast Expressway general-purpose lanes, northbound

For the following facilities, travel-time data are collected between 3:00 PM and 7:00 PM:

- Southeast Expressway HOV lane, southbound
- Southeast Expressway general-purpose lanes, southbound

Travel Time Trends During the Four-Hour Monitoring Periods[2]

I-93 North: Southbound HOV Lane and General-Purpose Lanes

Summary of findings:

Figure 4-18 presents 2002–11 travel-time data and associated curves for the four-hour PM monitoring period for the I-93 North HOV lane and general-purpose lanes. This diagram is an example of the HOV data analysis that has been done.

Findings of the analysis include the following:

- In 2002 and 2003, travel times in the HOV lane during each daily period of operation were significantly higher than in 2004–08 and 2009–11, and they showed considerable peaking. The travel times rose gradually from 6:00 AM until around 8:00 AM, when they reached a maximum, and then they decreased until the end of operations at 10:00 AM. However, from 2004 through 2011, the travel times in the HOV lane showed no peaking at all, as the congestion at the point where it merges with the general-purpose lanes was eliminated when the Zakim Bridge and the southbound tunnel opened.[3]
- In general, the travel times in the general-purpose lanes from 2004 through 2011 were significantly lower than those observed in 2002 and 2003, because the major

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[2] This section originally appeared, in different form, in Asante et al.

[3] Seth Asante, Ryan Hicks, and Efi Pagitsas, MPO staff, memorandum to the Boston Region MPO dated January 12, 2012, “Historical Trends: Travel Times and Vehicle Occupancy Levels for I-93 North and Southeast Expressway HOV and General-Purpose Lanes,” Table A-1, “Central Artery/Tunnel Project Milestones with Potential Effects on I-93 HOV Facilities.”

cause of congestion at the point where the general-purpose lanes merge with the HOV lane was eliminated when the Zakim Bridge and southbound tunnel opened.

- The HOV lane was 10% to 24% more efficient than the general-purpose lanes, in terms of persons moved per lane per hour, during 2002–11.
- For the I-93 North HOV southbound lane, the travel time advantage over the general-purpose lanes has been ranging over the years from 4 to 6 minutes, approximately. The lowest travel times for both types of lanes were in 2008, but they have increased slightly since, more so for the general-purpose lanes than for the HOV lanes.

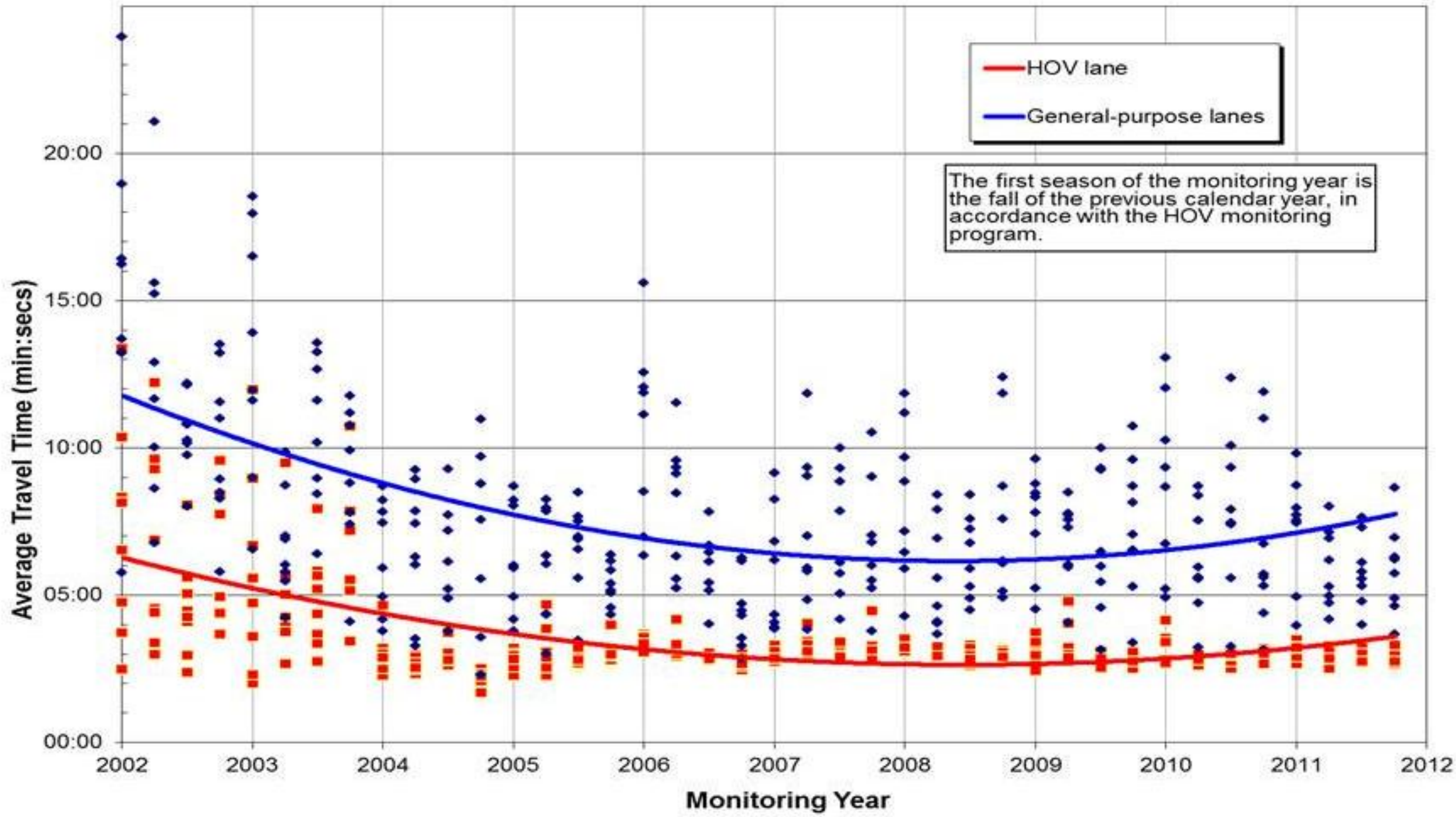

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FIGURE 4-18
I-93 North Travel Times: Southbound Travel Lanes,
AM Peak Period, 2002-11

Congestion Management Process

Southeast Expressway: Northbound HOV Lane and General-Purpose Lanes

Summary of findings:

- There were significant increases in travel times from 2002 to 2011 in the HOV lane. Travel times in the HOV lane increased over a substantial portion of the four-hour monitoring period for each year of observation.
- The gradual increase in travel times for the HOV lane in recent years might be attributable to several factors. One possible factor is that the merging of HOV traffic with general-purpose-lane traffic at the north end of the HOV lane may be a cause of delay in the HOV lane.

Southeast Expressway: Southbound HOV Lane and General-Purpose Lanes

Summary of findings:

- The HOV lane's average travel times in 2009 through 2011 appear to be slightly lower than those in 2003 through 2008.
- The general-purpose lanes' average travel time curve for the 2009–11 period is slightly lower than their average travel time curve for the 2003–08 period for most of the four-hour monitoring period.
- Although the average travel times in the HOV lanes are faster than the average travel times in the general-purpose lanes, the travel time savings that the HOV lanes offer do not meet the standard set by the Department of Environmental Protection (DEP).

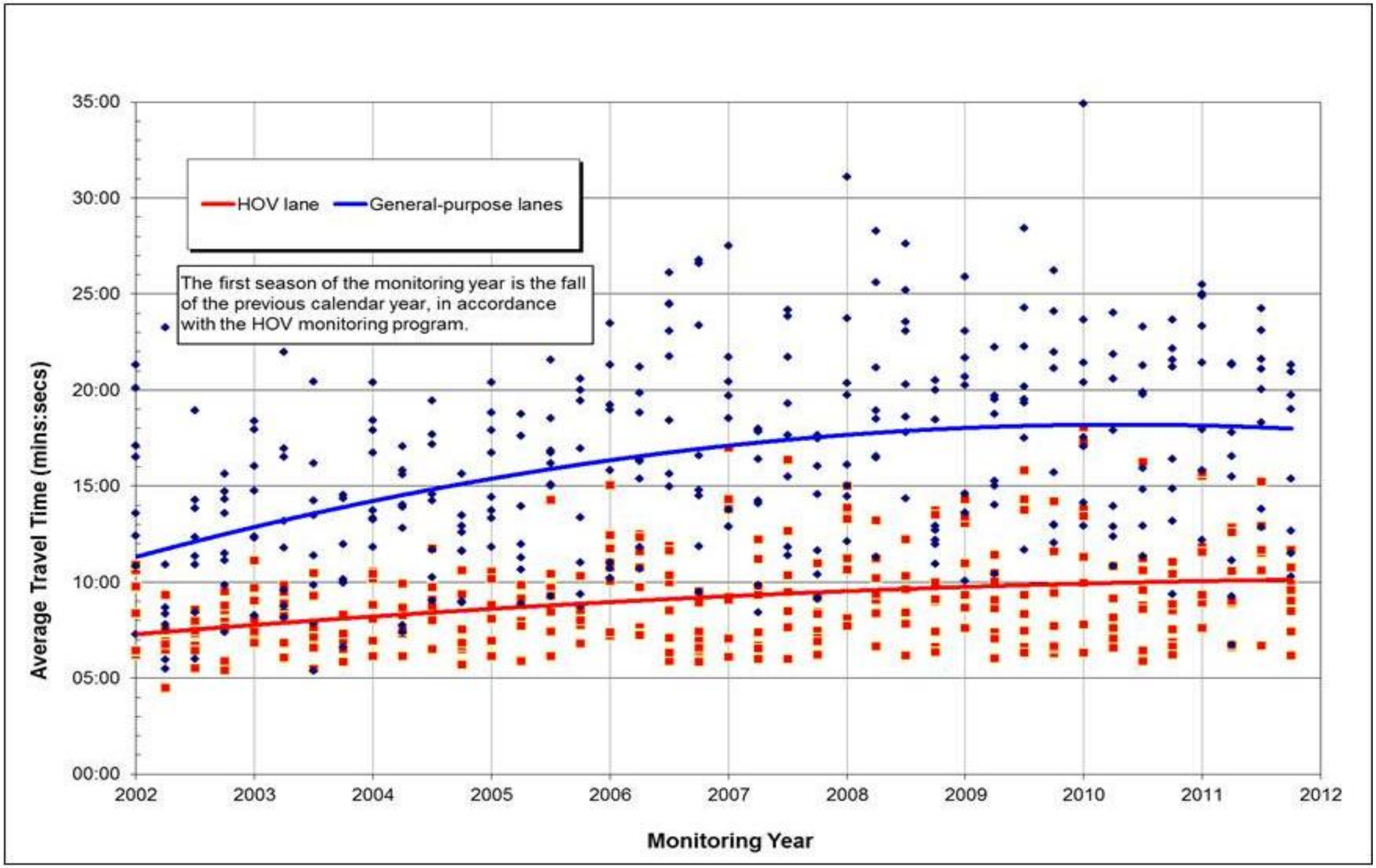

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FIGURE 4-19
Southeast Expressway Travel Times: Northbound Travel Lanes, AM Peak Period, 2002-11

Congestion Management Process

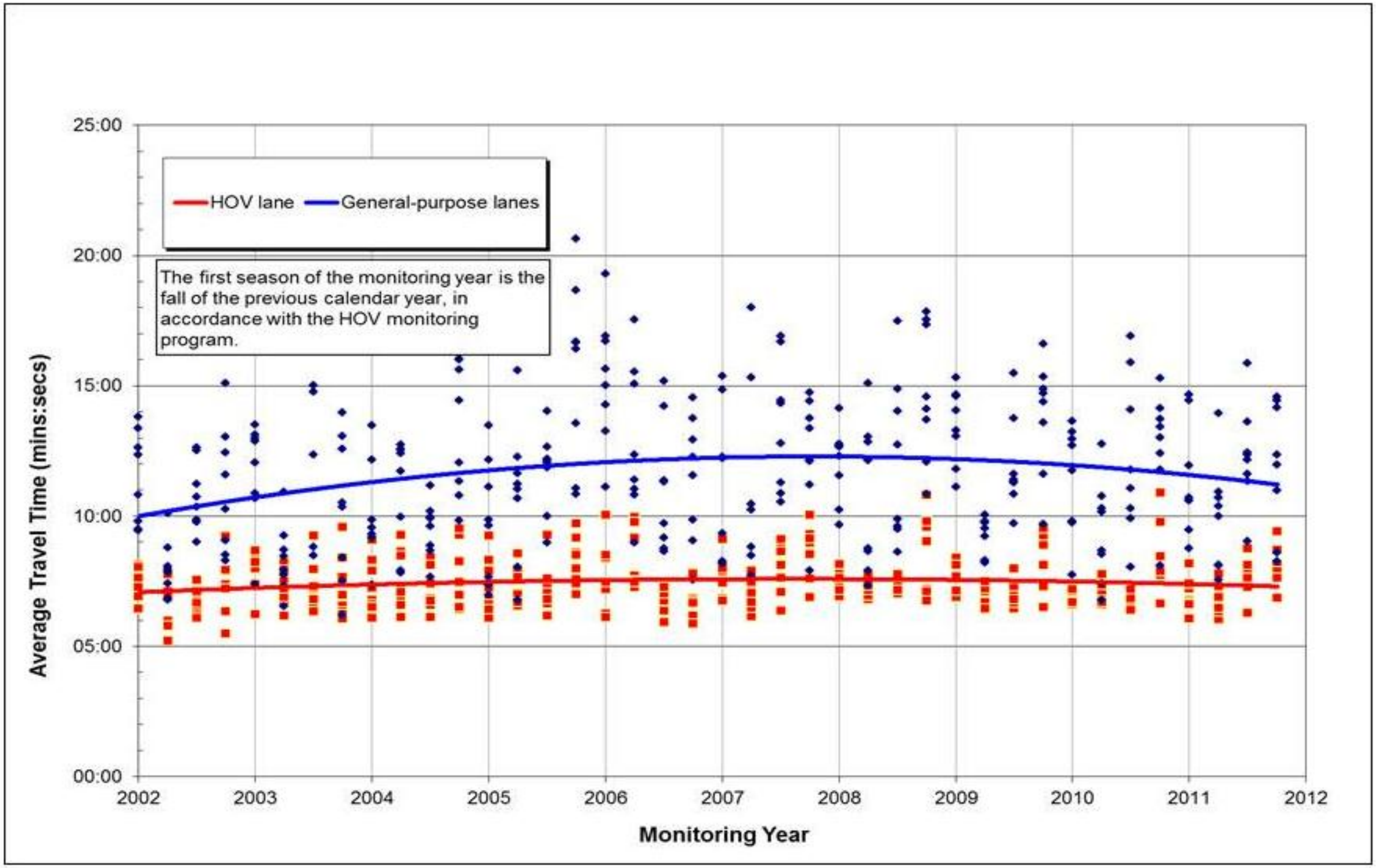

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FIGURE 4-20
Southeast Expressway Travel Times: Southbound Travel Lanes, PM Peak Period, 2002-11

Congestion Management Process

Vehicle Volumes and Occupancy Levels

MPO staff and MassDOT Highway Division staff also collect vehicle-occupancy data by lane. This effort takes place during the spring and fall and is carried out only for the AM hours of operation. The vehicle-occupancy counts are not conducted for the Southeast Expressway's southbound HOV lane or for its general-purpose lanes during the PM hours of operation because, typically, the amount of daylight does not allow for it when this collection takes place in the spring and fall quarter. For most vehicles smaller than a microbus, data collectors count persons, up to five. Since occupancy of large buses, microbuses, and police, fire, and emergency-medical-services vehicles is difficult to count accurately, data collectors simply tally the number of vehicles in each of these categories without counting passengers.

I-93 North: Southbound HOV Lane and General-Purpose Lanes

Table 4-2 presents the total number of vehicles and persons, average vehicle occupancy levels, number of persons per hour per lane, and other data for the I-93 North HOV lane and general-purpose lanes.

- Between 2006 and 2009, the average volume of vehicles in the general-purpose lanes was 1,617 to 1,689 vehicles per hour per lane. The average vehicle occupancy level in the general-purpose lanes remained fairly constant between 2004 and 2011 (between 1.08 and 1.13).
- The HOV lane was more efficient than the general-purpose lanes, as it carried more persons per hour per lane (16% more persons per hour per lane than the general-purpose lanes in 2011).

Southeast Expressway: Northbound HOV Lane and General-Purpose Lanes

The total number of vehicles and persons, average vehicle occupancy levels, persons per hour per lane, and other data are given for the HOV lane and general-purpose lanes of the Southeast Expressway in Table 4-3.

From 2005 through 2011, the average vehicle occupancy levels for the HOV lane were 2.71 to 2.84 persons per vehicle, and there was no noticeable trend emerging from these values. For the same period, the average vehicle occupancy level for the general-purpose lanes was 1.05 to 1.12 persons per vehicle.

Southeast Expressway: Southbound HOV Lane and General-Purpose Lanes

Vehicle occupancy counts are not conducted for the PM hours of operations on the Southeast Expressway; therefore, vehicle occupancy analysis was not performed for the Southeast Expressway southbound HOV lane or general-purpose lanes.

Non-HOV Occupancy Counts

In the federal fiscal year 2011 Unified Planning Work Program (UPWP), the CMP work program was updated to include monitoring of vehicle occupancies at certain locations where there are currently no HOV lanes. The purpose of this monitoring is to provide data for future HOV system planning and other transportation-demand-management work. Vehicle occupancy data collection took place between June 15 and July 7, 2010, at seven locations:

- Route 3 South, northbound, between Exits 15 and 16 in Weymouth
- Route 24, northbound, near the I-93 ramps in Randolph
- Route 24, southbound, near the I-93 ramps in Randolph
- I-90, eastbound, between Exits 13 and 14 in Natick
- I-95 North, northbound, between Exits 30A and 30B in Lexington
- I-93 North, northbound, between Exits 41 and 42 in Wilmington
- I-93 North, southbound, between Exits 41 and 42 in Wilmington

Table 4-4 summarizes and analyzes the results from the occupancy counts.

TABLE 4-2
Historical Vehicle Counts: I-93 North, Southbound, AM Peak Period (6:00 AM–10:00 AM)

Year	Facility	Total Vehicles	Total Persons	Vehicles per Hour per Lane	Persons per Lane	HOV Lane Efficiency Rate*	Persons per Vehicle
	HOV	2,300	7,015	575	1,754	1.21	3.05
2004	General	10,291	11,556	1,286	1,445		1.12
	All	12,591	18,571	1,049	1,548		1.47
	HOV	2,669	8,017	667	2,004	1.24	3
2005	General	11,746	12,888	1,468	1,611		1.1
	All	14,415	20,905	1,201	1,742		1.45
	HOV	2,820	8,022	705	2,005	1.1	2.84
2006	General	13,007	14,568	1,626	1,821		1.12
	All	15,827	22,589	1,319	1,882		1.43
	HOV	2,989	8,372	747	2,093	1.14	2.8
2007	General	12,934	14,640	1,617	1,830		1.13
	All	15,923	23,012	1,327	1,918		1.45
	HOV	3,090	8,545	772	2,136	1.13	2.77
2008	General	13,512	15,164	1,689	1,896		1.12
	All	16,602	23,709	1,383	1,976		1.43
	HOV	2,982	8,347	745	2,087	1.19	2.8
2009	General	12,980	14,062	1,623	1,758		1.08
	All	15,962	22,409	1,330	1,867		1.4
	HOV	2,920	7,599	730	1,900	1.23	2.6
2010	General	11,066	12,403	1,383	1,550		1.12
	All	13,986	20,002	1,166	1,667		1.43
	HOV	3,192	8,876	798	2,219	1.16	2.78
2011	General	13,410	15,255	1,676	1,907		1.14
	All	16,602	24,131	1,383	2,011		1.45

* HOV lane efficiency rate = Persons per hour per HOV lane divided by persons per hour per general-purpose lane, multiplied by 100.

TABLE 4-3
Historical Vehicle Counts: Southeast Expressway, Northbound, AM Peak Period (6:00 AM–10:00 AM)

Year	Facility	Total Vehicles	Total Persons	Vehicles per Hour per Lane	Persons per Hour per Lane	HOV Lane Efficiency Rate*	Persons per Vehicle
	HOV	3,898	10,769	975	2,692	1.7	2.76
2005	General	22,688	25,367	1,418	1,585		1.12
	All	26,586	36,135	1,329	1,807		1.36
	HOV	4,156	10,954	1,039	2,738	2.28	2.64
2006	General	18,237	19,215	1,140	1,201		1.05
	All	22,393	29,937	1,120	1,497		1.34
	HOV	4,104	11,229	1,026	2,807	2.02	2.74
2007	General	20,301	22,204	1,269	1,388		1.09
	All	24,405	33,432	1,220	1,672		1.37
	HOV	3,559	9,855	890	2,464	1.73	2.77
2008	General	21,004	22,751	1,313	1,422		1.08
	All	24,563	32,606	1,228	1,630		1.33
	HOV	3,925	10,630	981	2,658	1.81	2.71
2009	General	21,779	23,515	1,361	1,470		1.08
	All	25,704	34,145	1,285	1,707		1.33
	HOV	4,030	11,455	1,008	2,864	2.16	2.84
2010	General	19,383	21,169	1,211	1,323		1.09
	All	23,413	32,623	1,171	1,631		1.39
	HOV	4,568	12,420	1,142	3,105	2.42	2.72
2011	General	18,528	20,547	1,158	1,284		1.11
	All	23,096	32,967	1,155	1,648		1.43

* HOV lane efficiency rate = Persons per hour per HOV lane divided by persons per hour per general-purpose lane, multiplied by 100.

TABLE 4-4
Non-HOV-Lane Occupancy Counts: Summary, Summer 2010 Monitoring

Location	Direction of Traffic	Date of Data Collection	Time of Data Collection	Number of Lanes	Total Vehicles	Total Persons	Average Weighted Vehicle Occupancy	Fraction of Vehicles with 1 Person	Fraction of Vehicles with 2 Persons
Route 3	Northbound	June 15, 2010	7:00–9:00 AM	3	5,965	7,279	1.22	0.88	0.1
Route 24	Northbound	July 7, 2010	7:00–9:00 AM	3	9,112	11,284	1.24	0.84	0.12
Route 24	Southbound	June 29, 2010	4:00–6:00 PM	3	11,078	14,384	1.3	0.8	0.17
I-90	Eastbound	June 23, 2010	7:00–9:00 AM	3	9,208	10,912	1.19	0.88	0.11
I-95	Northbound	June 22, 2010	4:00–6:00 PM	4	10,376	11,794	1.14	0.91	0.08
I-93	Northbound	July 7, 2010	4:00–6:00 PM	4	12,843	15,936	1.24	0.83	0.12
I-93	Southbound	June 29, 2010	7:00–9:00 AM	4	11,630	12,858	1.11	0.93	0.06

PUBLIC TRANSIT

Using data from the U.S. Census Bureau's 2006–10 American Community Survey (ACS), CTPS staff estimated that approximately 16% of residents of the Boston Region MPO area commute to work via some form of public transit; this is slightly higher (by 1 percentage point) than the transit mode share for 2000 given in the census for that year. Of all work trips within the MPO region, 62% have destinations in Boston and Cambridge; 39% of all trips destined to the urban core are made by transit.[4] Based on the 2010 census figures, approximately 56% of the population in the MPO region lives within walking distance of MBTA transit service.[5]

This chapter provides performance data on the bus, rapid transit, and commuter rail services that have been collected by CTPS's Transit Service Planning Group and the MBTA. The data reported in this chapter are taken from service planning efforts that include data collection, monitoring, and assessment that support the MBTA's biennial service plans, in addition to its Capital Investment Program, Program for Mass Transportation (the MBTA's long-range plan), and other ongoing service planning evaluations.

The established performance measures used by the CMP with regard to public transit are on-time performance and passenger crowding.

System Ridership

According to the most recent data, the MBTA system provides, on average, slightly more than 1.2 million total passenger trips each weekday: about 711,800 on the rapid transit system, 368,100 on the bus system, 129,400 on the commuter rail system, and 4,372 on commuter ferries .[6,7] Figure 4-21 shows the total annual MBTA system

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[4] As stated in the Program for Mass Transportation (PMT), prepared by the Central Transportation Planning Staff for the Massachusetts Bay Transportation Authority (MBTA), December 2009, p. G-8.

[5] Walking distance to transit (used to identify the potential transit market area) is defined as a distance of 1/2 mile or less from a rail station and 1/4 mile or less from a bus stop. Population is based on the 2010 U.S. census.

[6] American Public Transportation Association, *APTA 2011 Q3 Ridership Report,* December 2011.

[7] Massachusetts Bay Transportation Authority, "Ridership and Service Statistics," thirteenth edition, 2010.

ridership for rapid transit, bus, and commuter rail from 2002 to 2011. [8,9] The subsequent figures show a more detailed view of ridership trends for each mode in the MBTA system. During the period shown, overall system ridership was lowest in 2002 (with slightly under 342 million total trips provided) and peaked in 2004 (with over 392 million total trips). Total commuter rail ridership was highest in late 2008, and steadily decreased to levels significantly lower than in the years leading up to 2008 (see Figure 4-22). Rapid transit ridership was lowest in 2002–04 and has generally remained high since then (see Figure 4-23). Bus ridership peaked in 2004, with over 12 million trips per month, and has remained near or below 11 million trips per month since 2005 (see Figure 4-24). Commuter boat ridership has remained fairly stable but exhibits distinct seasonal patterns, with higher ridership in the summer months (see Figure 4-25). Rail and bus ridership also exhibit seasonal patterns, with lower ridership in the winter months, but these patterns are less consistent.

[8] Data source: National Transit Database, “Monthly Module Adjusted Data Release" (accessed June 30, 2011). The figures represent the total number of unlinked passenger trips. Bus ridership includes both directly operated and third-party-operated MBTA services, as well as bus rapid transit and trackless trolleys. Demand-response ridership and boat ridership are excluded because the totals are too low to represent visually in the same chart.

[9] Boston Region MPO’s definition of an unlinked trip: the number of passengers who board public transportation vehicles. When a count is conducted to ascertain this number, passengers are counted each time they board a vehicle no matter how many vehicles they use to travel from their origin to their destination. An unlinked trip is any segment of a linked trip.

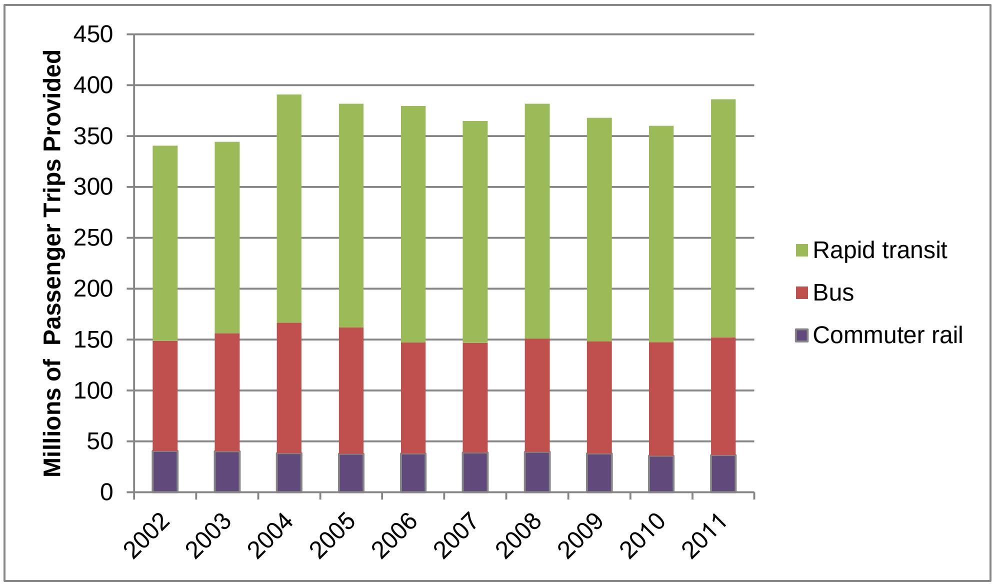

FIGURE 4-21
MBTA System Ridership, 2002–11

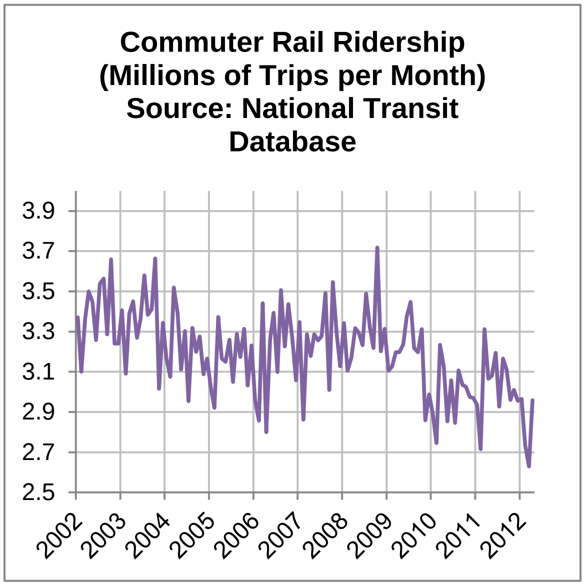

Figure 4-22
Commuter Rail Ridership
2002–12

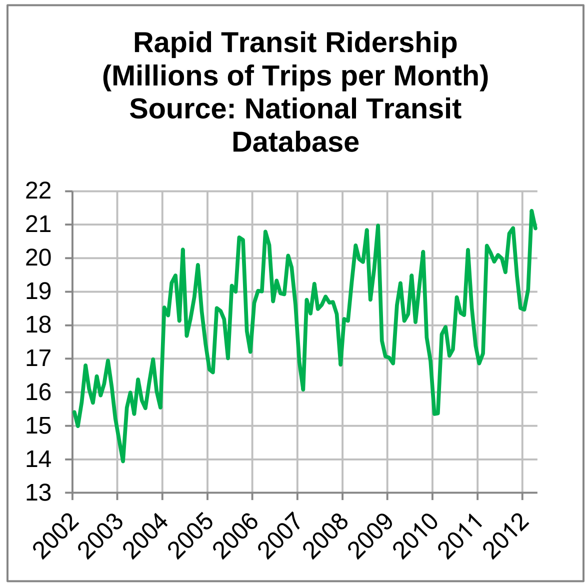

Figure 4-23
Rapid Transit Ridership
2002–12

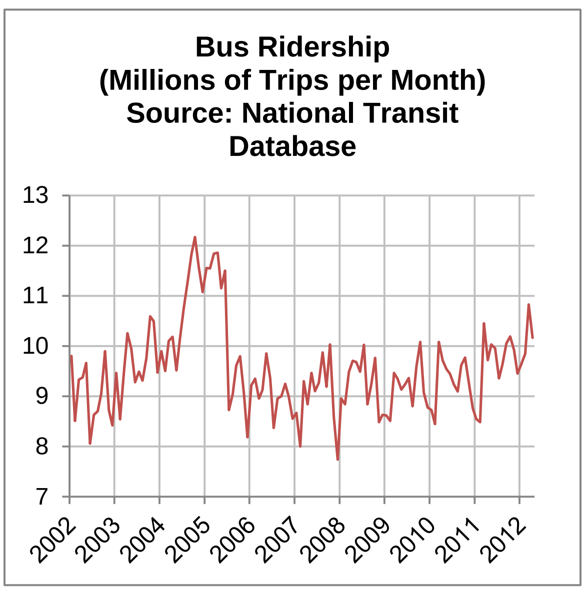

Figure 4-24
Bus Ridership
2002–12

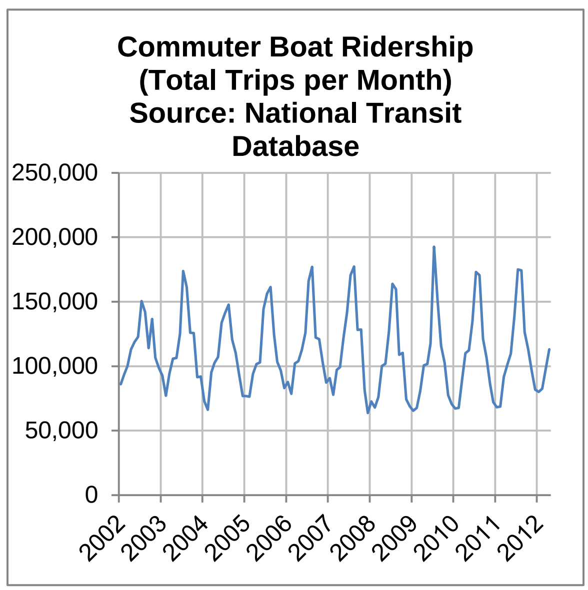

Figure 4-25
Commuter Boat Ridership
2002–12

Specific Transit Performance Measures Methodology

On-Time Performance (Schedule Adherence)

All of the on-time performance (schedule adherence) measures are established by the MBTA.[10] The measures used by the CMP are:

- A commuter train is considered on time if it arrives five minutes or less after the scheduled arrival time. A commuter rail line is considered to be on time if 95% of train trips met this criterion. *(MBTA performance measure)*
- A commuter boat is considered on time if it arrives five minutes or less after the scheduled arrival time. A commuter boat route is considered to be on time if 95% of boat trips met this criterion. *(MBTA performance measure)*
- A rapid transit (light rail or heavy rail) train is considered on time if it leaves the first station on the line within 1.5 times the scheduled interval between trains (a headway of at most 150%). Rapid transit trains and Green Line trains on the Central Subway (from Lechmere to Copley) are considered to be on time if 95% of trips met this criterion. Surface Green Line trains are considered to be on time if 85% of trips met this criterion. *(MBTA performance measures)*
- For MBTA bus routes, the standard used for measuring on-time performance has two parts, as described below. The first part of the standard (the bus timepoint tests) generates information that is used by the second part of the standard (the bus route test) to determine whether or not a bus route is considered on time. *(MBTA performance measures)* Bus Timepoint Tests: To determine whether a bus is on time at an individual timepoint after the beginning of a route, such as the end of a route, or scheduled point in between, the MBTA uses two different tests based on service frequency:
    - Scheduled Departure Service: A route is considered to provide scheduled departure service for any part of the day in which it operates less frequently than one trip every 10 minutes (headway greater than 10 minutes). For scheduled departure services, customers generally time their arrival at bus stops to correspond with the specific scheduled departure times. Using the bus timepoint test for scheduled departure service, a trip must leave its origin timepoint within 3 minutes after the scheduled departure time, leave its mid-timepoint within 7 minutes of the scheduled departure time, and arrive at its destination between 3 minutes and 5 minutes after the scheduled arrival time. The CMP does not factor in scheduled departure service into on-time performance because the objective of on-time

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[10] MBTA 2010 Service Delivery Policy, available on the MBTA's website, www.mbta.com (accessed June 24, 2011).

performance as a CMP performance measure is to measure the congestion that a bus would experience while in transit.

- Walk-Up Service: A route is considered to provide walk-up service for any part of the day in which it operates every ten minutes or oftener (headway less than or equal to 10 minutes). For walk-up service, customers can arrive at a stop without looking at a schedule and expect only a brief wait. Using the bus timepoint test for walk up service, a trip must arrive at the destination timepoint within 20 percent of the scheduled run time.

- Bus Route Test: The second part of the bus on-time performance standard determines whether or not a route is on time by measuring the proportion of timepoints on the routes that are on time. Using the bus route test, over the entire service day, 75 percent of all timepoints on the route must pass their timepoint tests to be considered on time.

Buses

In 1996, CTPS began an ongoing comprehensive manual ridecheck program to collect ridership and schedule adherence data for all MBTA bus routes. In late 2007, the MBTA began to acquire buses that are equipped with automated passenger counters (APCs). Until sufficient buses with APC equipment are fully deployed and functional throughout the bus system, a combination of APC data and existing ridecheck data will be used to determine vehicle loads. The MBTA expects that they will soon be able to use only vehicle load data that are collected using the APCs. CTPS currently augments the APC and ridecheck data with manual pointchecks.

Figure 4-26 shows the MBTA’s routes color-coded by the percentage of timepoints that met the bus route timepoint test.

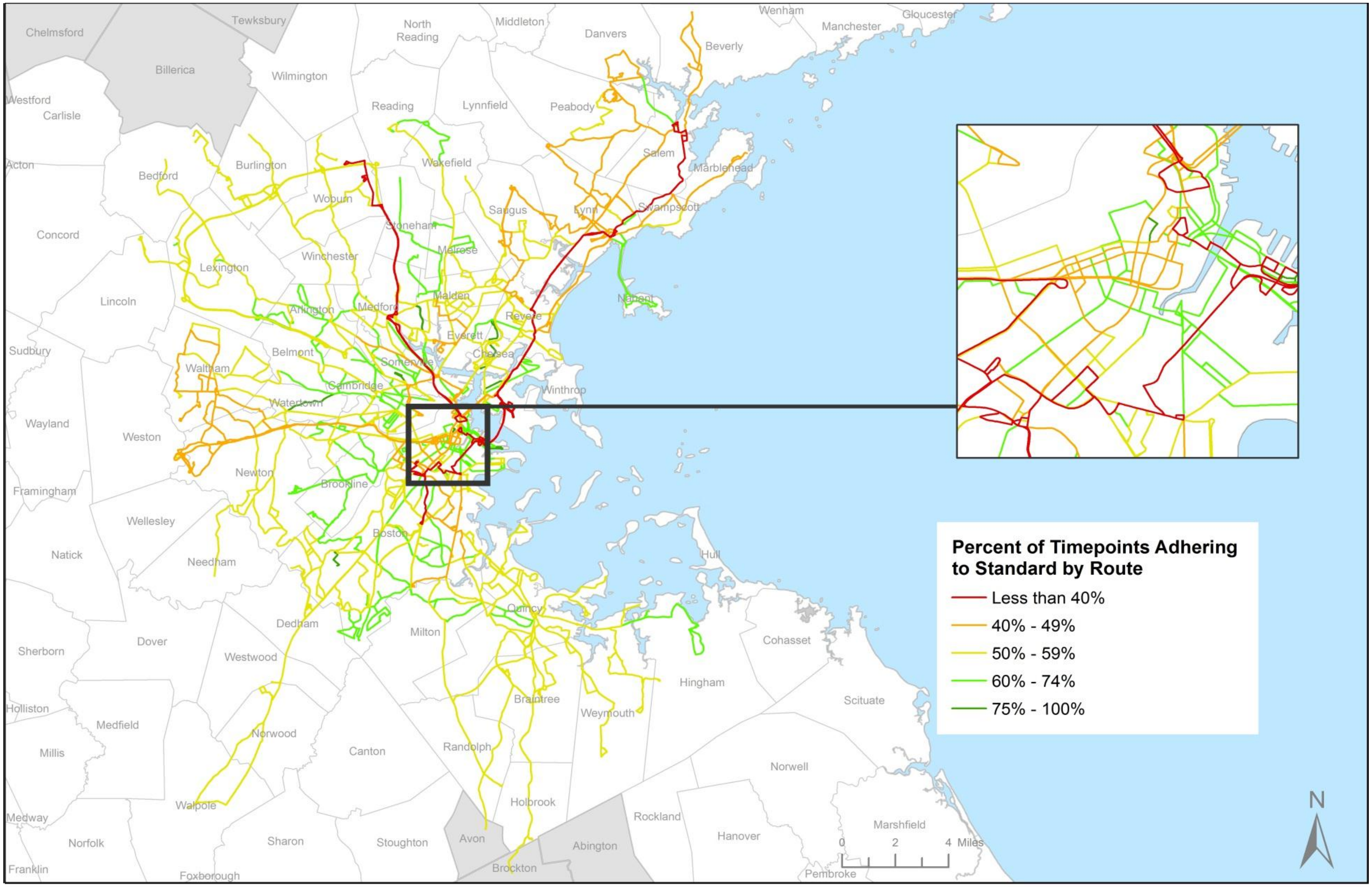

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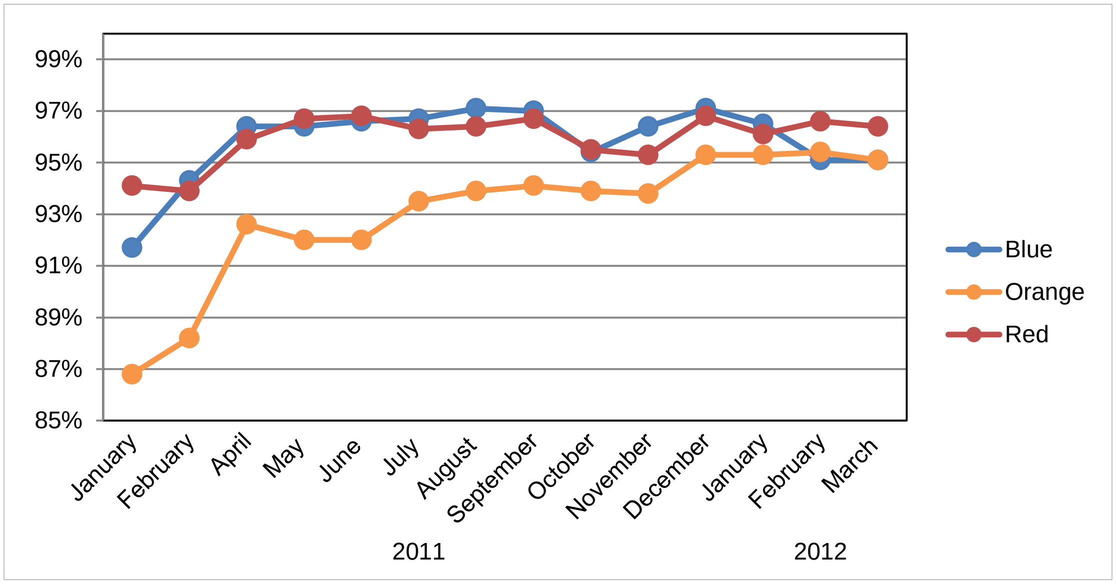
FIGURE 4-26
On-Time Performance (Schedule Adherence)
2010

Congestion Management Process

Heavy Rail

Figure 4-27 shows the percentage of trips in the heavy rail system that were on time (within 150% of the scheduled headway) from January 2011 to March 2012. On average, 95.6% of Blue Line trains, 91.3% of Orange Line trains, and 95.7% of Red Line trains were on time during that period.

Figure 4-27
Heavy Rail: Percent of Trips Operating on Time,
January 2011–March 2012



Light Rail

On-time performance data for the Green Line trains (the Mattapan line does not have an AVI detector) are collected using MBTA AVI (automatic vehicle identification) detectors. The Mattapan line on-time performance data is collected through staff ridechecks. Table 4-5 shows the percentage of light rail trips that met the on-time performance threshold (within 1.5 times of the scheduled headway, as described above) for each light rail line in the MBTA system. The Mattapan High-Speed Line and the outbound B Branch (west of Kenmore Station) of the Green Line did not meet the 85% performance threshold; the other lines met the threshold.[11]

[11] For details regarding the on-time performance threshold for light rail, see Performance Measures. For Green Line trains, AVI detector data from 3/8/2011 were used; for the Mattapan Line, data were provided by a CTPS pointcheck at Ashmont Station on March 8, 2011. Data for the Mattapan High-Speed Line in the outbound direction were not collected. Data for the E Branch of the Green Line were collected at Copley Square Station.

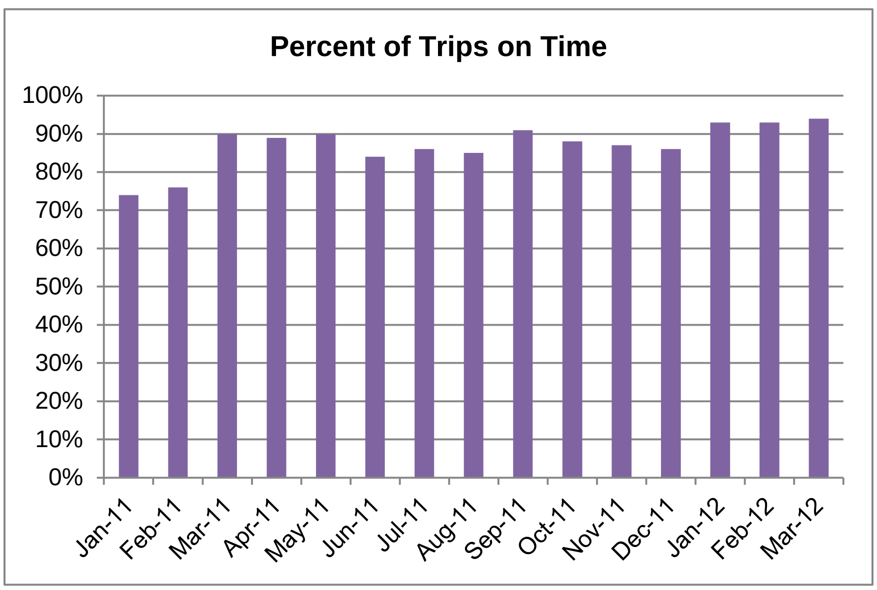
TABLE 4-5
Light Rail: Percent of Trips Operating on Time, March 2011

Line	Inbound	Outbound	All Trips
Green Line: B	90%	81%	85%
Green Line: C	90%	87%	89%
Green Line: D	90%	86%	87%
Green Line: E	87%	92%	89%
Mattapan High-Speed Line	81%	no data	81%

Commuter Rail

Figure 4-28 shows the percentage of commuter rail trips, throughout the entire system that operated on time (within five minutes of the scheduled arrival time) from January 2011 through March 2012. Table 4-6 shows the percentage of trips that operated on time for each line in December 2011, February 2012, and March 2012.[12]

Figure 4-28
Commuter Rail: Percent of Trips Operating on Time (Entire System), January 2011–March 2012



[12] Data source: MBTA monthly "ScoreCards," available on the MBTA's website, www.mbta.com (last accessed July 4, 2011). Data for November 2010 and March 2011 were not available.

TABLE 4-6
Commuter Rail: Percent of Trips Operating on Time, December 2011, February 2012, and March 2012

Line	Dec. 2011	Feb. 2012	Mar. 2012
Fairmount	97%	98%	96%
Fitchburg	90%	88%	87%
Franklin	95%	96%	96%
Greenbush	98%	99%	97%
Haverhill	94%	95%	94%
Kingston/Plymouth	96%	99%	99%
Lowell	94%	97%	96%
Middleborough	95%	99%	97%
Needham	94%	97%	94%
Newburyport	89%	93%	91%
Providence	88%	91%	91%
Rockport	87%	84%	84%
Providence/Stoughton	93%	96%	94%
Worcester	95%	96%	96%

Commuter Boat

The commuter boat routes have good on-time performance. Table 4-7 displays the percentages of on-time arrival for commuter boats in the region. All routes performed better than the schedule adherence standard (95% of trips on time) by at least 2% between January 2011 and April 2011.[13]

TABLE 4-7
Commuter Boat: Percent of Trips Operating on Time, January–April 2011

Commuter Boat Route	Percentage of Weekday Trips on Time
F1: Boston – Hingham	98%
F2/F2H: Boston – Quincy/Hull/Logan Airport	97%
F4 Inner Harbor Ferry: Boston – Charlestown	100%

[13] MBTA, Final 2008 Service Plan, p. 49, 2008.

Passenger Crowding

Passenger crowding is measured in terms of the ratio of the number of passengers to the number of seats on the vehicle. A value at or above the established threshold indicates crowded conditions. For purposes of identifying mobility concerns, CMP staff use the MBTA thresholds for passenger crowding, which are set forth in the 2010 Service Delivery Policy.[14] The passenger load thresholds are summarized in Table 4-8.

[14] MBTA, 2010,Service Delivery Policy, p. 14.

TABLE 4-8
Passenger Loads: MBTA Thresholds

Service Type	Seats per Vehicle/Car/ Vessel	Area	Crowding Threshold (Passengers per Seat): Early AM, AM Peak, Midday School, & PM Peak	Crowding Threshold (Passengers per Seat): Midday Base, Evening, Late Evening, Night/Sunrise, & Weekends
Bus	31–57 (depending on model)	Surface routes	1.40	1.00
		Tunnel portions of BRT routes	1.40	1.40
Green Line	44–46 (depending on model)	Core Area	2.25	1.40
		Surface	2.25	1.00
Mattapan (High-Speed Line)	40	(All)	2.10	2.10
Blue Line	42	Core Area	2.25	1.40
		Outside Core Area	2.25	1.00
Orange Line	58	Core Area	2.25	1.40
		Outside Core Area	2.25	1.00
Red Line: #1 and #2 cars	62–63 (depending on model)	Core Area	2.70	1.40
		Outside Core Area	2.70	1.00
Red Line: #3 cars	50	Core Area	3.34	1.74
		Outside Core Area	3.34	1.00
Commuter Rail	94–185 (depending on model)	(All)	1.10	1.00
Boat	149–400 (depending on model)	(All)	1.00	1.00

Buses

For buses (including bus rapid transit and trackless trolley routes), the passenger crowding threshold is 1.40 passengers per seat during peak periods. Passenger load

data are collected through a combination of CTPS ridechecks (onboard observations by CTPS staff) and APC data from MBTA vehicles. Each MBTA bus route is indicated as having passed or failed the passenger load standards for the weekday, Saturday, and Sunday monitoring times. Figure 4-29 displays the MBTA bus routes that either passed or failed the passenger load standards on any day of the week.

Rapid Transit

The most recently available load data for the rapid transit system are contained in the MBTA's 2008 Service Plan.[15] Only pass/fail data are available. These are summarized in Table 4-9. The lines that have excessive passenger loads include the Blue Line, the Green Line's B, C, and D branches in the evenings, and the Green Line's B and D branches and Red Line in midday.

[15] MBTA. 2008. Final 2008 Service Plan, p. 49 (accessed July 11, 2011).

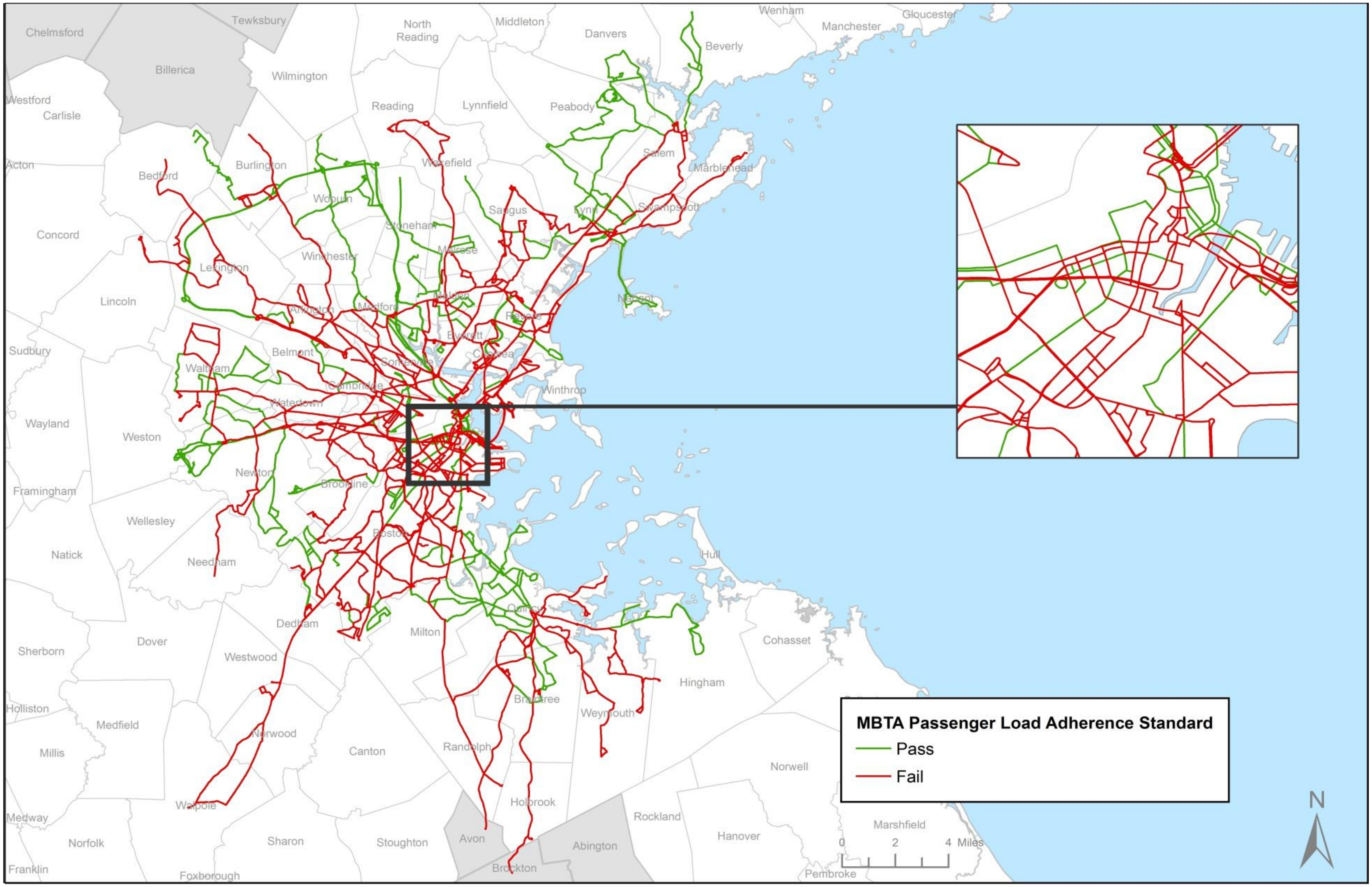


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FIGURE 4-29
Passenger Load Adherence for MBTA Bus Routes
2011

Congestion Management Process

TABLE 4-9
Passenger Loads: Rapid Transit

Line	Area	Early AM	AM Peak	Midday Base	Midday School	PM Peak	Evening	Late Evening
Blue	Core	Pass	Pass	Pass	Pass	Pass	**Fail**	**Fail**
	Non-core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Orange	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Non-core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Red (Ashmont)	Non-core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Red (Braintree)	Non-core	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass
Red (main)	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Non-core	Pass	Pass	**Fail**	Pass	Pass	Pass	Pass
Green (subway)	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Green (B)	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Non-core	Pass	Pass	**Fail**	Pass	Pass	**Fail**	**Fail**
Green (C)	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Non-core	Pass	Pass	Pass	Pass	Pass	**Fail**	Pass
Green (D)	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Non-core	Pass	Pass	**Fail**	Pass	Pass	**Fail**	**Fail**
Green (E)	Core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Non-core	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Mattapan High-Speed Line	Non-core	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Commuter Rail

Table 4-10 shows the average and maximum passenger loads on peak-period commuter trains, as observed in the fall of 2010. Only the Lowell Line violated the MBTA vehicle load standard for commuter rail, and only in the PM peak period. All of the other lines met the standard.

TABLE 4-10
Passenger Loads: Commuter Rail, AM and PM Peak Periods, Fall 2010

Line	Average Passengers per Seat (All Peak Trains)	Maximum Passengers per Seat (AM-Peak Trains)	Maximum Passengers per Seat (PM-Peak Trains)
Fairmount	.09	.16	.15
Fitchburg	.71	.97	.96
Franklin	.66	.87	.93
Greenbush	.47	.70	.56
Haverhill	.66	.97	.92
Lowell	.67	.92	1.12
Needham	.52	.74	.74
Newburyport/Rockport	.73	1.05	.93
Old Colony	.52	.77	.69
Providence	.77	.96	.98
Stoughton	.68	.82	.91
Worcester	.72	.87	1.00

Commuter Boat

Table 4-11 displays the commuter boat passenger-load data that was collected in July 2008. All three MBTA-monitored commuter boat routes have a PM maximum passenger load of 95% or above; however, all AM and PM average passenger loads for all commuter boat routes are less than 26%. If a commuter boat is filled to capacity on a given trip, the extra passengers must wait for the next departing boat to complete their trip.

Table 4-11
Passenger Loads: Commuter Boat,
AM and PM Peak Periods, July 2008

Commuter Boat Line	AM Average Passenger Load	PM Average Passenger Load	AM Maximum Passenger Load	PM Maximum Passenger Load
F1 Boston (Rowes Wharf-Hingham)	.23	.22	.84	.95
F2 Boston (Long Wharf-(Quincy/Hull/Logan)	.18	.26	.76	1.00
F4 Boston - Charlestown	.07	.20	.29	1.00

PARK-AND-RIDE LOTS[16]

The CMP staff conducts regular inventories of park-and-ride lots at MBTA commuter rail, commuter boat, rapid transit, and express bus stations. Inventories were conducted in 2000, 2002, 2005–06, and 2009–10. For each station, detailed information is recorded, including: general, disability, and bicycle parking capacity and utilization; parking fee payment methods; pedestrian and bicycle access to the station; station accessibility for individuals with disabilities; and amenities such as shelters and benches.

The tables in this section show the results of the most recent park-and-ride lot survey in detail. Results relating to bicycle parking are summarized in the section on Bicycle and Pedestrian Facilities in System Performance Monitoring.

Park-and-Ride Lot Performance Measures

The performance measures used for assessing park-and-ride lots are *percent lot utilization* and the *observed time that a lot fills up*.

Lot Utilization

The CMP classifies lot utilization results for each station into one of three categories:

- Full – 85% or more of the general spaces (as opposed to disability spaces) are typically filled.
- Partially full – 50% to 85% of the general spaces are filled; the lot is well utilized, but there would still be spaces available if demand were to increase.
- Underutilized – Less than 50% of the general spaces are filled.

A *mobility concern* is defined as a situation where a lot is full or underutilized according to the above definitions. (Note: Several stations are served by more than one lot; in such cases, the available parking for all lots, regardless of owner [for example, MBTA, private, or town ownership], is combined into one utilization measure.)

Data Collection Method

The most recent inventory of park-and-ride lots was conducted during the morning peak period of a typical weekday between January 2009 and August 2010.[17] Previous

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[16] Resident-only parking at a station is municipally owned, and its use is restricted to residents of the municipality that owns the parking facility. Resident-only parking is excluded from all totals and utilization percentages.

inventories were conducted in 2000, 2002, and 2005–06. The types of data collected included the parking lot's ownership, parking cost and restrictions, number of parking spaces, number of occupied spaces, the time at which all the parking spaces became occupied (if this occurred before the end of the peak period), commuter amenities at the station, accessibility to the station, accessibility to the platform, and bicycle and pedestrian amenities at and around the station.

Surveyors were instructed to stay at each parking lot until it was full or until the end of the AM peak period, whichever occurred first. This varied by station. After the parking lot filled or after the last AM-peak-period train, the surveyor inventoried the parking lot and filled in all the questions on the survey form. A separate survey form was filled out for each parking lot, as some stations have more than one lot. In this way, it is known at what time each individual parking lot filled.

All park-and-ride lots that are known to serve commuters on the MBTA system were inventoried (lots serving only commuters who use non-MBTA transportation were not surveyed). This includes all MBTA, private, and town-owned lots at all commuter rail, rapid transit, and commuter boat stations, and origin locations of all express buses. The locations of these lots were ascertained from past inventories, information provided on the MBTA's website, and anecdotal information provided by MBTA and CTPS staff.

Parking utilization was defined for this survey as the percentage of public non-disability parking spaces used by the end of the MBTA-defined AM peak period. All of the parking spaces referred to in this chapter are public non-disability spaces, unless otherwise indicated.

Many stations have permit-only parking lots in addition to public lots. Permit parking lots are either municipally or privately owned, and their use is restricted to permit holders; in many cases, local residency is required in order to secure a permit.

This collection and evaluation method that the Boston Region MPO uses to collect park-and-ride utilization rates differs from the MBTA's collection method. The MBTA collects utilization rates based on parking revenue for an entire day, in which the rates are averaged out for one month per year. Once the number of vehicles parked is calculated, the utilization rates for each MBTA lot is increased five percent for contingency

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[17] The survey for each lot was a one-time observation performed on a day that was believed to be a typical working weekday. If unusual circumstances occurred on the day of observation and were known to the surveyor, the survey of that parking lot was done again. Examples of unusual circumstances include delays in MBTA service, inclement weather, construction, major events, holidays, and traffic incidents with major impacts throughout the transportation network.

purposes. The MBTA does not collect parking utilization data for any private lots near MBTA stations. Due to differences in the collection methods between the MBTA and the performance standards of the Boston Region MPO's Congestion Management Process, the park-and-ride utilization data displayed in this document may not match the data for park-and-ride lots shown on the MBTA website.

Monitoring Results

An analysis of inventory results indicated that 58% of parking at all stations combined, for all modes in the MBTA system, was utilized on a typical weekday morning. The breakdown by type of service is 56% utilization for the commuter rail system, 61% utilization for the rapid transit system, 93% utilization for express bus lots, and 69% utilization for commuter boat lots.[18] Figure 4-30 shows the park-and-ride utilization rates by individual station. Table 4-12 displays the park-and-ride utilization by commuter rail line.

[18] Some stations with parking are served by both commuter rail and rapid transit. To avoid confusion, these stations are all categorized as rapid transit stations in this inventory.

TABLE 4-12
Park-and-Ride Lot Utilization Overview for MBTA-Owned and Municipal Lots: Commuter Rail System

Commuter Rail Line(s)	Number of Parking Spaces	Percent Utilization
Lines Terminating at North Station	*9,929*	*61%*
Fitchburg Line	1,543	62%
Haverhill Line	1,832	61%
Lowell Line	3,162	82%
Newburyport/Rockport Line	3,392	40%
Lines Terminating at South Station	*23,917*	*53%*
Fairmount Line	389	34%
Framingham/Worcester Line	3,543	59%
Franklin Line	3,589	60%
Greenbush Line	2,662	37%
Kingston/Plymouth Line	3,127	51%
Middleborough/Lakeville Line	2,924	43%
Needham Line	1,122	53%
Providence/Stoughton Line	6,561	61%
Total	**33,846**	**56%**

Fitchburg Line **–** At the 15 stations on the Fitchburg Line that provide parking, no lot filled[19] during the AM peak period. There are a total of 1,543 parking spaces available for public use on the Fitchburg Line. Sixty-two percent of all parking spaces on this line were full. There are an additional 467 parking spaces on this line, all resident-only; 88% of them were used.

Haverhill Line **–** At the 12 stations on the Haverhill Line that have parking lots, no lot filled to capacity during the AM peak period. Sixty-one percent of the 1,832 parking spaces available for public use at the 12 stations were full. There are an additional 300 parking spaces, exclusively for residents of Reading, at Reading Station. Of those parking spaces, 84% were used by the end of the morning peak period. There are also 29 permit parking spaces at Bradford Station, 21 of which were occupied.

Lowell Line **–** Of the seven stations on the Lowell Line that have parking, Wedgemere was the only one whose lot filled during the AM peak period. A total of 3,162 parking spaces are available for public use on this line, and 82% of them were full. Of the 45

[19] Full or filled lots are lots with 85% or more utilization.

resident-only parking spaces at West Medford Station, 44 were in use during the AM peak period.

Newburyport/Rockport Line **–** Of the 16 stations on the Newburyport/Rockport Line that have parking lots, Ipswich was the only one whose lot was full during the AM peak period. There are 3,392 parking spaces available for public use on the Newburyport/Rockport Line, 40% of which were used.[20] There are 174 parking spaces that require parking permits at Beverly Station, 76% of which were used.[21] There are 121 permit parking spaces at Salem Station, 120 of which were used. There are an additional 16 parking spaces, all resident-only, at Swampscott Station. All of those parking spaces were full.

Fairmount Line **–** Readville[22] and Fairmount are the only two stations on the Fairmount Line that have parking. Of the 389 parking spaces, 34% filled during the AM peak period. There are no permit-only parking spaces on this line.

Framingham/Worcester Line **–** Of the 14 stations on the Framingham/Worcester Line that have parking, no lot filled during the AM peak period. Of the 3,543 parking spaces on this line, 59% filled during the AM peak period. Sixty-eight percent of the 71 resident-only parking spaces at Natick Station were in use during the AM peak period. There are an additional 68 permit parking spaces at Framingham Station, 44% of which were full.

Franklin Line **–** Of the 11 stations on the Franklin Line, Endicott was the only one whose parking lot filled completely during the AM peak period. There are 3,589 parking spaces on the Franklin Line that are available for public use, 60% of which filled during the AM peak period.[23] There are an additional 45 permit parking spaces at Franklin Station, 36 of which were full.

Greenbush Line – At the seven stations on the Greenbush Line that have parking, no lot filled during the AM peak period. There are 2,662 parking spaces available for public use, 37% of which filled during the AM peak period.

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[20] This low percentage reflects in part the very low parking rate at Lynn Station, where only 23% of the 914 available spaces were utilized.

[21] In late 2009, after the station was surveyed, a new lot was opened at Beverly Depot, with an additional 102 spaces.

[22] Readville Station is served by both the Fairmount Line and the Franklin Line. To avoid confusion, Readville is included under the Fairmount Line.

[23] These totals exclude Readville Station; see the previous note.

Kingston/Plymouth Line **–** Of the seven stations on the Kingston/Plymouth Line that have parking, no lot filled during the AM peak period. There are 3,127 parking spaces available on this line, 51% of which filled during the AM peak period. There are an additional 175 permit parking spaces at Kingston Station; 81% of these spaces were full. There is no AM-peak-period train service at Plymouth Station; all of the 96 parking spaces there were empty.

Middleborough/Lakeville Line **–** Of the six stations on the Middleborough/Lakeville Line that have parking, no lot filled during the AM peak period. There are 2,924 parking spaces available for public use; 43% filled during the AM peak period.

Needham Line **–** None of the eight station parking lots filled during the AM peak period. There are 1,122 parking spaces available for public use; 53% filled during the AM peak period.

Providence/Stoughton Line **–** At the 10 stations on the Providence/Stoughton Line that have parking, no lot filled completely during the AM peak period. There are 6,561 parking spaces available for public use on the Providence/Stoughton Line, 61% of which filled during the AM peak period. There are an additional 1,126 parking spaces, all resident-only parking; 80% were in use during the AM peak period.

Rapid Transit

Table 4-13 shows the percentage of parking utilization by rapid transit line.

TABLE 4-13
Park-and-Ride Lot Utilization Overview for MBTA-Owned and Municipal Lots: Rapid Transit System

Rapid Transit Line	Number of Parking Spaces	Percent Utilization
Blue Line	3,739	55%
Green Line	1,960	44%
Orange Line	4,469	66%
Red Line and Mattapan High-Speed Line	8,926	64%
Total	**19,094**	**61%**

Blue Line – The Blue Line has six stations that have parking lots. None of those lots filled during the AM peak period. Fifty-five percent of the 3,739 public parking spaces were used by the end of the AM peak period.[24] At Wonderland Station, 39 spaces are for permit holders only; 11 of those spaces were occupied.

Green Line – None of the six parking lots at stations on the Green Line was observed to be full during the AM peak period. Forty-four percent of the 1,960 parking spaces on the Green Line available for public use were in use.

Orange Line – Six stations on the Orange Line have parking lots. Parking was not filled to capacity at any of these stations during the AM peak period. There are 4,469 parking spaces on this line available for public use, 66% of which were used. In addition, there are 39 permit parking spaces at Green Street stations, 24 of which were used.

Red Line and Mattapan High-Speed Line – Ten stations on the Red Line and Mattapan High-Speed Line have parking lots. Parking was not filled to capacity at any of those stations during the AM peak period. Of the 8,926 parking spaces available for public use, 64% filled.

Commuter Boat

Quincy/Fore River, Hingham, and Hull are the three commuter boat terminals that have parking lots. Quincy/Fore River has 350 parking spaces, only 17% of which were in use during the AM peak period. This parking lot is also available for overnight parking for Logan Airport and Harbor Island users. The parking rates are different for day and overnight users. Seventy-eight percent of the 1,986 parking spaces at the Hingham terminal were in use during the morning peak period. There are 240 parking spaces at the Hull terminal, 67% of which were in use.

Express Bus

The express bus parking lot in Woburn was surveyed. The Woburn lot has 75 spaces, 70 of which filled during the AM peak period. The Watertown lot was not surveyed for this inventory but had been surveyed in 2005. At that time, the lot had 194 spaces, 79% of which were full by the end of the AM peak period.

Comparison with 2000 and 2005–06 Inventory Results

An inventory of park-and-ride parking lots was conducted as part of the Mobility Management System (MMS), now called the CMP, in the fall of 2005 and winter of

[24] Over 1,000 of the available parking spaces on the Blue Line are provided by private operators at Wonderland Station. These spaces are included in the totals and utilization percentages.

2006. Another inventory had been conducted in the fall of 2002 for the CMP, known at that time as the Congestion Management System (CMS). The 2002 inventory included only park-and-ride lots located within Boston Region MPO municipalities. A prior inventory, covering the entire MBTA system, was conducted in 2000; that inventory was not associated with the CMP but is comparable to the later inventories. This section primarily compares the 2009–10 inventory results with those from 2005–06; it also compares them with the 2000 results for selected subjects. A direct comparison with the 2002 inventory results was not possible because complete data were not available for 2002.

In the 2009–10 inventory, far fewer park-and-ride lots at commuter rail stations were found to be full than in previous inventories. In 2009–10, the lots at only two commuter rail stations (Endicott and Wedgemere) were 100% full, compared to 28 stations in the 2005–06 inventory and 14 stations in 2000. The percentage of parking utilization also decreased, from 82% in 2000 and 73% in 2005–06 to 56% in 2009–10. Only two lines saw an increase in parking utilization between the 2005–06 and 2009–10 inventories: the Haverhill Line and the Lowell Line. Figure 4-31 shows the change in utilization rates between the 2005–06 monitoring period and the 2009–10 monitoring period.

Results were similar for park-and-ride lots at rapid transit stations. In 2009–10, no rapid transit stations were 100% full, compared to 11 stations in the 2005–06 inventory and 14 stations in the 2000 inventory. All four rapid transit lines saw decreases in parking utilization, and the total parking utilization percentage for all rapid transit stations that had park-and-ride lots decreased from 97% in 2000 to 85% in 2005–06, and to 61% in 2009–2010.

The decreased parking utilization rates observed between the 2009–10 inventory and that in 2005–06 may have been the result of the MBTA increases in parking fees or the downturn of the economy at the time, as the former counts were taken during that period.

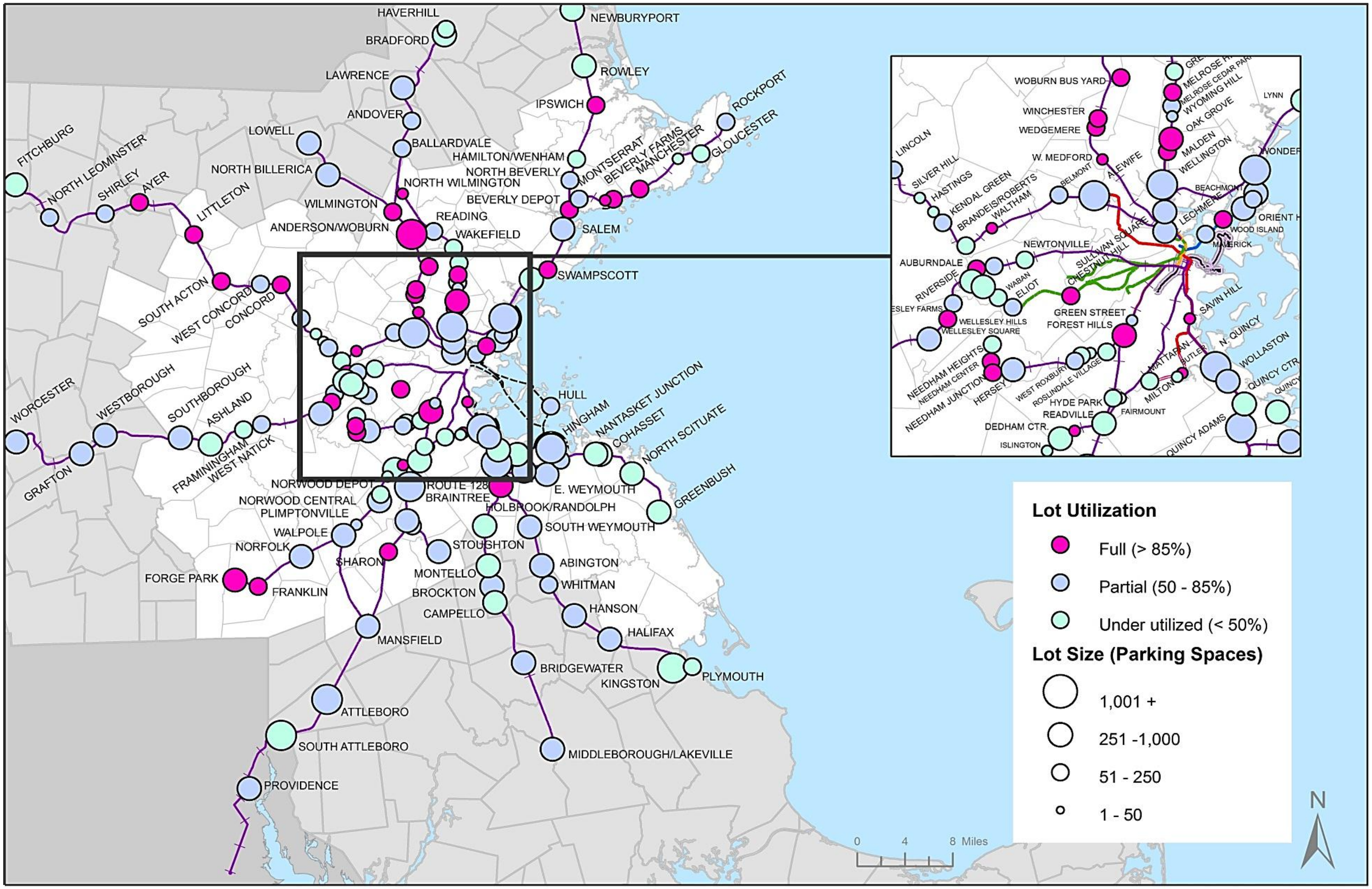
Parking utilization increased at the commuter boat terminals, from 62% in 2005–06 to 69% in 2009–10. The express bus parking lot at Woburn was 93% full in the 2009–10 inventory, a decrease from 2005–06, when it filled to 100% of capacity. Commuter boat lots and express bus parking lots were not monitored in the 2000 inventory.

Since the 2005–06 inventory, daily parking fees at many park-and-ride lots have increased. On November 15, 2008, the rates for most MBTA lots had increased by $2.00. This meant that at most commuter rail stations, daily parking fees went from $2.00 to $4.00, and at most rapid transit stations, fees went from between $3.00 and $5.00 to between $5.00 and $7.00. Previous parking rate increases took place on January 6, 2003 (by 50 cents at rapid transit stations and one dollar at commuter rail

stations), and on July 1, 2005 (a 50-cent increase at most rapid transit stations). In January 2011, the MBTA announced the availability of monthly parking permits for 65 stations. The rate for these lots is $70 per month.

In January 2007, the MBTA increased commuter rail fares and restructured rapid transit fares. When paying with a CharlieCard (a reloadable, plastic fare medium), the rapid transit fare is now a flat fee of $1.70. Rapid transit fares were previously subject to a more complex structure in which they varied depending on trip length, origin, and destination.

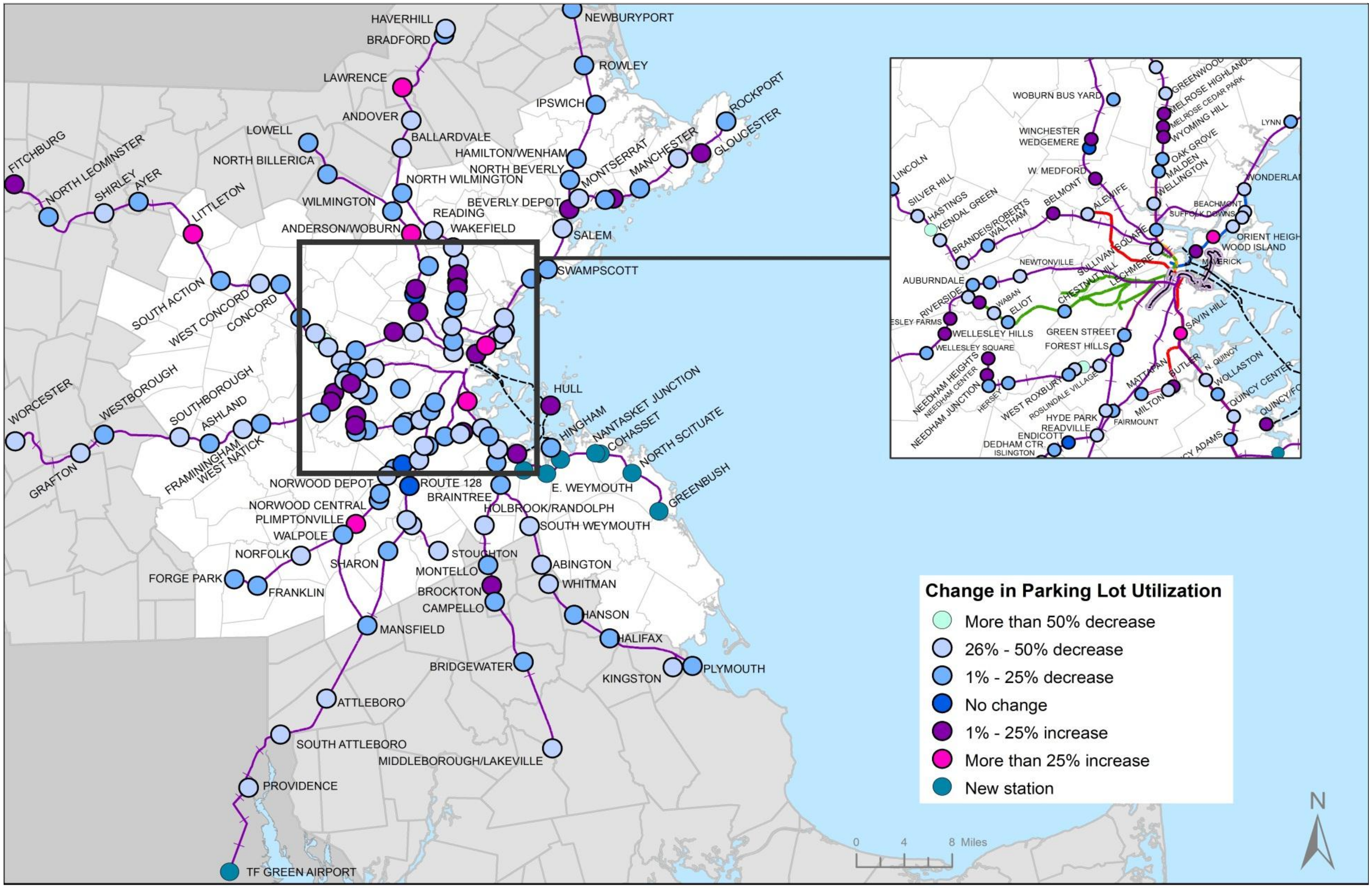
There have been changes in parking capacity since the 2005–06 inventory was completed. Systemwide, public (non-permit) parking capacity decreased by about 1,000 spaces. This resulted from the removal of approximately 3,500 parking spaces at certain stations and the addition of about 2,500 spaces at other stations. This figure does not include more than 3,000 spaces that were added for the Greenbush Line, which opened in October 2007.



BOSTON REGION MPO

FIGURE 4-30
Park-and-Ride Lot Capacity and Utilization, 2009-10 Inventory

Congestion Management Process



BOSTON REGION MPO

FIGURE 4-31
Change in Park-and-Ride Utilization Rates, 2005-06 Inventory and 2009-10 Inventory

Congestion Management Process

MassDOT Park-and-Ride Lots

MassDOT park-and-ride lots are located along major highways. All-day parking is usually free. Table 4-14 shows utilization rates for the seven MassDOT park-and-ride lots within the MPO region for which data were available.[25]

The Rockland park-and-ride lot has 440 parking spaces, which is the most of any MassDOT park-and-ride lot, and the highest parking utilization rate at 76%. The reason behind the high usage rate could be that both the Plymouth and Brockton and the Logan Express bus services serve this lot. The reason the Framingham bus lot has relatively low parking utilization, despite bus service, is that there is another park-and-ride lot nearby that is also served by bus service and is located closer to the MassPike.

[25] Data were provided to CTPS directly by MassDOT for February 2005 through June 2009.

TABLE 4-14
Park-and-Ride Lot Utilization for MassDOT-Operated Lots*

Location	Highway	Operating Agency	Date Monitored	Capacity	Utilization
Canton	I-93 & Rte. 138	MassDOT Highway Division	Nov-07	120	57%
Framingham	**Near Rte. 9 and Rte. 30**	**MassDOT Highway Division**	**Jun-08**	**114**	**18%**
Framingham	**I-90/MassPike**	**MassDOT Highway Division**	**Jun-09**	**120**	**66%**
Milton	I-93 & Granite Ave.	MassDOT Highway Division	Nov-07	200	47%
Pembroke	Rte. 3 & Rte. 139	MassDOT Highway Division	May-07	90	7%
Rockland	**Rte. 3 & Rte. 228**	**MassDOT Highway Division**	**Nov-07**	**440**	**76%**
West Newton (Exit 16)	I-90/MassPike	MassDOT Highway Division	Feb-05	165	65%
Total				**1,249**	**57%**

*Park-and-ride lots that are served by bus service are indicated in bold.

BICYCLE AND PEDESTRIAN FACILITIES

Background

The bicycle and pedestrian modes were added to the CMP program in response to feedback on earlier reports. The approach used for reporting on these modes is different from the approach used for the roadway, transit, park-and-ride, and HOV-lane facilities. Bicycle and pedestrian facilities are not evaluated for congestion; instead the focus here is on how the region's transportation infrastructure accommodates these modes. Bicycling and walking provide an alternative to motorized roadway travel, especially when they can be used in conjunction with transit, and thus they are instrumental in reducing motorized, single-occupancy-vehicle travel and improving air quality.

The MBTA's Bikes and Transit Advisory Committee (which was active until it was disbanded in 2009) was composed of interested members of the public and representatives from the MBTA, the Executive Office of Transportation and Public Works (which merged with other agencies to form MassDOT in November 2009), the Metropolitan Area Planning Council, and other interested organizations; it advised the MBTA on issues related to bicyclist access to transit. Using qualitative and quantitative data, as well as personal experience, the committee recommended which stations should have bicycle racks installed. Following the advice of the committee, the MBTA has been funding the installation of bicycle racks as resources become available. CMP staff participated in the committee meetings in an advisory capacity. Even though the Bikes and Transit Advisory Committee no longer meets as a committee, it played an important role in implementing bicycle accessibility improvements on the MBTA.

Progress and Achievements

The Bikes and Transit Advisory Committee advised the MBTA in its process of outfitting a portion of its bus fleet with bicycle racks, which began in 2006. Bicycle racks on buses allow customers to use their bicycles at both ends of their transit trips (arriving at and departing from a station or stop). The racks make it easier for customers to make connections to and from transit via bicycle. Recently the MBTA started another bicycle accessibility project—a pilot program that extends the hours when bicycles are allowed on the Blue Line. In 2009, the MBTA was awarded stimulus funds to improve bicycle facilities. With these funds, the MBTA planned to install six additional Pedal & Parks (bike cages) and 50 Bike Ports (sheltered bicycle parking); they have already installed some Pedal & Park facilities and Bike Port facilities. As of the fall of 2011, over 70% of the MBTA's bus fleet, representing 83 bus routes, had been equipped with bicycle racks.

U.S Census Estimates

The estimated mode share of walking as the primary means of traveling to work increased slightly between 2000 and the 2006–10 period for commuters residing in the Boston Region MPO area .[26,27] From the 2000 census to the 2006–10 period, the number of Boston area residents who reported bicycling as their main means of traveling to work increased by over 7,000, to an estimated 16,100 (a mode share of just under 1%). This figure does not include those who used only a bicycle for a portion of their commute trip—for example, those who bicycled to a rail station where they transferred modes from bicycling to transit.

Based on Census 2000 figures, CTPS estimated that approximately 56% of the population within the Boston Region MPO area lives within walking distance of MBTA transit service.[28] Because so much of the Boston Region MPO's population lives near transit service (one-fourth mile from bus stops or one-half mile from rail), it is especially important to promote public transit use, particularly by providing a safe environment for pedestrians and bicyclists in the areas served by transit.

An interactive map of bicycle and pedestrian facilities in the region is hosted by the Metropolitan Area Planning Council (MAPC).

[26] The 2005–09 census figures represent an average over a five-year period and are the most recent data currently available that distinguish among transportation modes with smaller mode shares (for example, bicycle, taxicab, motorcycle).

[27] Journey-to-work figures are percentages based on a sample questionnaire. Only workers over 16 years of age are included; all primary and secondary school students, including those over 16 years of age, are excluded from the census survey. Furthermore, these are census data that are collected in early spring, when, according to counts in the Boston metropolitan area, bicycle volumes are about one-quarter of the peak-season volumes. The seasonal variations in pedestrian activity are not known; however, pedestrian volumes are assumed to be less variable than bicycle volumes. Another factor to consider is that the census questionnaire asks for the mode used for the longest portion of the work commute. Hence, a trip involving a two-mile bicycle trip to a rail station, a five-mile train ride, and a half-mile walk to the office would be classified by the census as a rail commute trip.

[28] Walking distance to transit is defined as 1/2 mile or less from a rapid rail station and 1/4 mile or less from a bus stop. This measure is used to identify the potential transit market area.

Data Collection

Inventories were conducted on a typical fair-weather workday between January 2009 and August 2010 and between August 2011 and October 2011. Bicycle parking and utilization data were collected during the first time period (January 2009 to August 2010) in concurrence with the inventory of vehicle parking at park-and-ride lots at MBTA stations (part of an earlier project). The remaining stations, those without vehicle parking, were inventoried separately, during the second time period (August 2011 to October 2011). A nearly identical methodology was used to conduct inventories in 2005–06 and 1999–2002.

In general, CTPS surveyors inventoried each station once. In some cases, the data obtained from the first visit were collected during cooler weather, and staff were concerned that it would adversely affect the number of bicycles parked at the station; in other cases, a major addition of bicycle parking spaces had occurred (such as a Pedal & Park facility). In these cases, an additional visit was made to the station. Data were collected using a survey form that recorded the number, location, and condition of bicycle racks, as well as the number of bicycles parked in the racks and elsewhere at the station. Data on amenities and other characteristics of the station and its vicinity were also collected, including the presence of bicycle paths and trails and bicycle lanes, lighting, and security, in and around the station.

At many of the MBTA stations that do not have bicycle parking, bicycle racks are located near the station on municipal property or along the sidewalks. These bicycle racks were included in the inventory if there was no bicycle parking at the transit station or if it appeared likely that the municipal bicycle racks would be convenient for transit riders. If bicycle racks were nearby but were very inconvenient for transit riders, they were not included in the inventory.

The observed utilization of the bicycle racks is assumed to be typical for the station. Detailed observations over time—an effort beyond the scope of the CMP—would be necessary to gather the true bicycle rack utilization due to the fluctuation of weather and work schedules, among other factors.

Bicycle Parking at Transit Stations

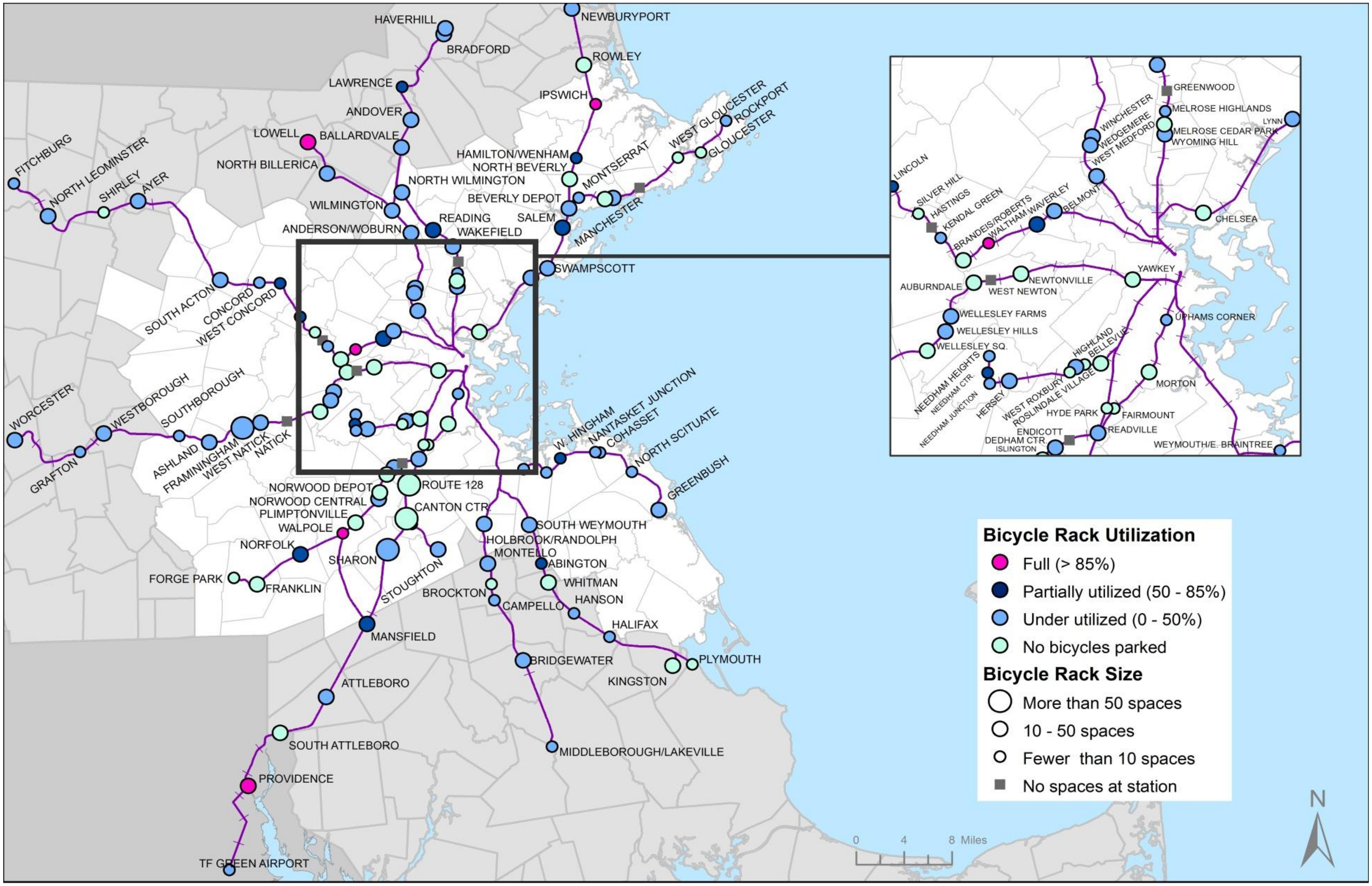
Bicycle parking at transit stations in the MBTA system is surveyed as part of the park-and-ride lot survey program. Additional stations that lack park-and-ride lots were surveyed by staff in the fall of 2011. Staff inventoried MBTA bike racks and racks owned by cities and towns at each of the 134 rapid transit stations, 122 commuter rail stations, three commuter boat terminals, and three major bus stops. Some of these stations have a significant amount of bicycle parking (for example, Davis Square on the Red Line),

while some have no bicycle parking facilities. The MPO hopes that the CMP will survey bicycle parking at all of the MBTA stations in the future.

The most recent inventory of some stations with park-and-ride lots and some stations that lack park-and-ride lots was conducted in 2009–11. Of the 265 stations included in the inventory, 80% have bicycle racks. This includes 116 of the 122 commuter rail stations, 91 of the 134 rapid transit stations, and three of the six boat terminals. Also included in this inventory were three major bus stops, two of which have bicycle racks. The station with the highest bike parking capacity is Alewife, with 321 spaces. Table 4-15 shows the percentages of bicycle rack utilization (on a typical weekday morning) by mode and line throughout the system. Figure 4-32 shows bicycle parking capacity and utilization by commuter rail station. Figure 4-33 shows bicycle parking capacity and utilization by rapid transit station.

Table 4-15
Bicycle Parking Capacity and Utilization, 2009–11 Inventory

Transit Line or Mode	Bicycles Parked	Number of Bicycle Parking Spaces	Percent Utilization
Commuter Rail			
Fairmount Line	3	76	4%
Fitchburg Line	49	191	26%
Framingham/Worcester Line	35	224	16%
Franklin Line	21	163	13%
Greenbush Line	18	57	32%
Haverhill Line	38	241	16%
Kingston/Plymouth Line	8	91	9%
Lowell Line	48	153	31%
Middleborough/Lakeville Line	17	79	22%
Needham Line	20	101	20%
Newburyport/Rockport Line	43	230	19%
Providence/Stoughton Line	71	296	24%
Commuter Rail Total	***370***	***1,856***	***20%***
Commuter Ferry			
Hingham - Rowes Wharf	9	16	56%
Charlestown Navy Yard	0	2	0%
Hull - Long Wharf	2	8	25%
Commuter Ferry Total	***11***	***26***	***42%***
Rapid transit			
Blue Line	72	240	30%
Green Line	195	612	32%
Orange Line	219	700	35%
Red Line	775	1,258	62%
Rapid Transit Total	***1,314***	***3,039***	***43%***
Silver Line Total	***53***	***229***	***23%***
Local Bus Total	***12***	***17***	***71%***
Total for all modes	**1,707**	**4,938**	**35%**



BOSTON REGION MPO	FIGURE 4-32 Bicycle Parking Capacity and Utilization for Commuter Rail Stations, 2009-11 Inventory	*Congestion Management Process*

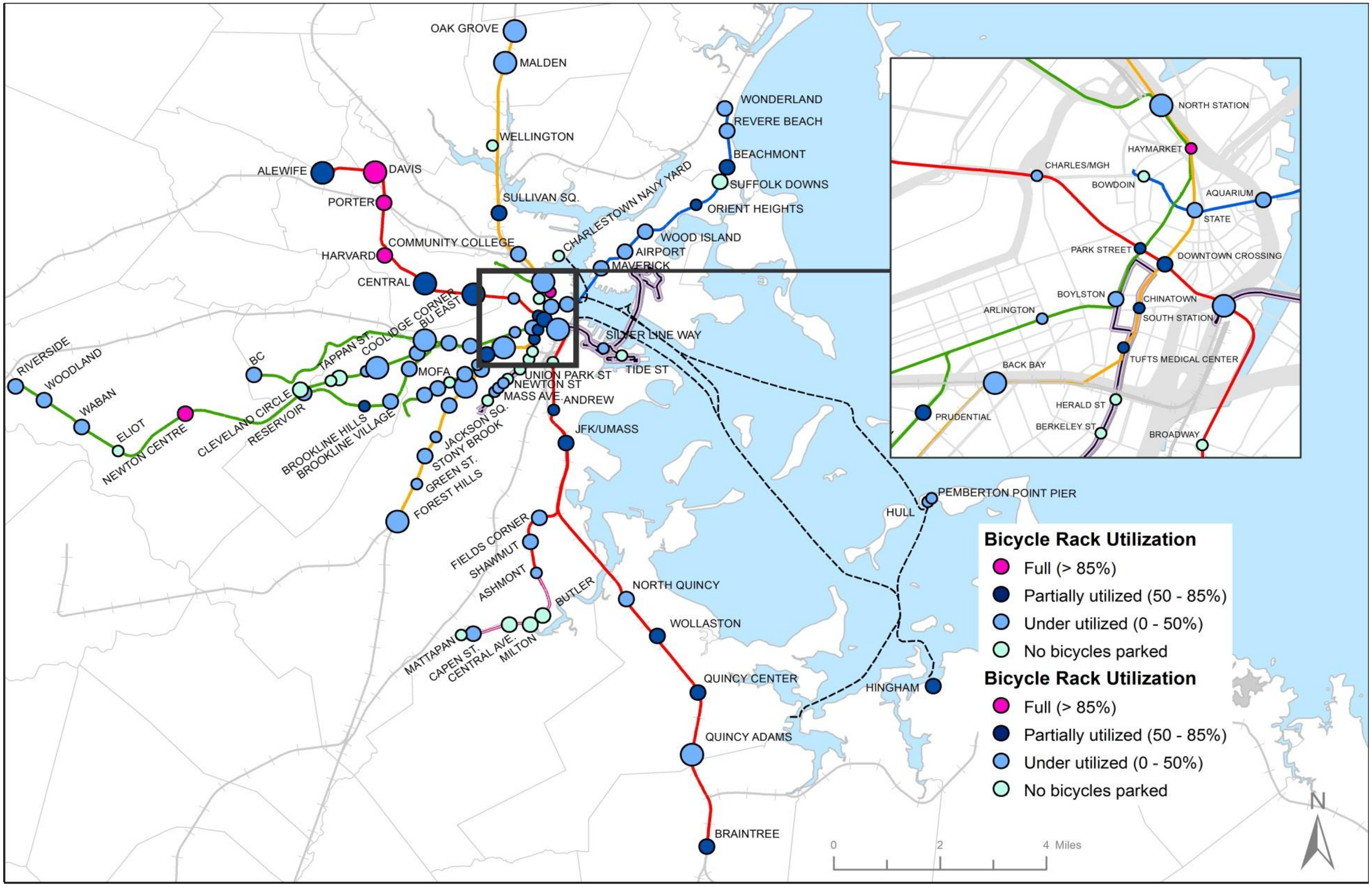


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FIGURE 4-33
Bicycle Parking Capacity and Utilization for Rapid Transit Stations, 2009-11 Inventory

Congestion Management Process

Bicycle Parking for Rapid Transit

Porter, Harvard, and Haymarket stations are at or over 100% of their capacity. Haymarket has only two parking spaces, both of which were full. Porter and Harvard have 39 and 27 parking spaces, respectively. Bicyclists sometimes attach their bicycles to poles, railings, and trees once the bicycle racks are full.

Harvard Station (Red Line), Central Station (Red Line), and Harvard Avenue Station (Green Line B Branch) were the only stations observed during the 2009–11 inventory to have more than 10 bicycles parked in areas other than the bicycle racks provided (such as locked to signs, benches, and railings) at the time of observation. This may be an indication that the existing racks are not located in areas that are perceived as safe; the racks are located in an inconvenient location; or the racks are at, near, or over their design capacity.

Bicycle Parking for Commuter Rail

The bicycle parking space utilization rate was 20% in the 2009–11 inventory. Ninety-five percent of the 122 stations in the commuter rail system have bicycle racks. The Providence/Stoughton Line had the most bicycles parked, with 71 parked at the racks. The Lowell and Greenbush lines had the highest bicycle rack utilization, with just over 30% of the bicycle rack spaces occupied. The Fairmount Line had the lowest bicycle rack utilization, at 4%. In all, 40 of the 122 commuter rail stations that had bike racks were observed to have zero bicycles parked. Six of the 122 stations observed did not currently have bicycle racks.

Bicycle Parking for Commuter Boat and Buses

Six commuter boat facilities were monitored in the 2009–11 inventory, which was the most recent inventory. Utilization was relatively high, at 42%. The number of bicycles parked at the Hingham terminal had almost doubled since the previous inventory (in 2006), while the number of bicycle parking spaces had decreased. The Hingham commuter boat terminal has racks that accommodate 16 bicycles, and in the 2009–11 inventory, 9 were parked there. In the 2009–11 inventory, eight bicycle parking spaces were installed at Hull; two bicycles were parked in the spaces. The Charlestown Navy Yard also had one bicycle rack installed (an inverted-U); no bicycles were parked at the rack. The Quincy/Fore River commuter boat terminal does not have bicycle racks, and no bicycles were parked near the dock. The only dock where people parked bikes somewhere other than a bicycle rack was Long Wharf.

Watertown Yard, Watertown Square, and Woburn Yard were the only major bus stops monitored in the 2009–11 inventory. Watertown Yard had five spaces, and there was one parked bicycle; several bicycles were parked near the bus shelter (which is several

hundred feet away from the rack). Watertown Square has 12 spaces, and 11 bicycles were observed parked there during the 2009–11 inventory. Several bicycles were parked at poles and trees around the area. Those bikes were probably parked there when the bicycle rack was full or very nearly full. There were no parking spaces at Woburn Yard, nor were any bicycles parked in the area.

Access to Transit Stations

Data related to pedestrian and bicycle access to transit stations were obtained from the 2009–11 CMP survey of MBTA park-and-ride lots.

The Boston MPO's website lists four types of pedestrian and bicycle amenities at the transit stations surveyed: sidewalks leading to the station, crosswalks leading to the station, bicycle paths (only significant multi-use paths) connecting the station to residential areas, and bicycle parking.

Problems and Needs

Following monitoring, congestion, mobility, and safety problems are identified as problem locations in need of detailed study and further action for the implementation of the recommended improvements. Most of the problem locations identified from monitoring fall into one of the following categories:

- Bottlenecks on expressways and interchanges
- Congested arterial corridors
- Congested intersections and high-crash intersections
- Park-and-ride lots that fill to capacity
- Overutilization or underutilization of available bicycle racks at MBTA stations
- Problematic, inconvenient, and potentially unsafe access to transit stations by pedestrians and bicyclists
- Transit routes (bus, rail, and boat) that experience delays and “bunching” due to roadway congestion, and passenger overcrowding
- Bottlenecks at points where an HOV lane merges with general-purpose lanes

IDENTIFIED CONGESTION PROBLEMS BY TYPE OF FACILITY

Roadways

Congested roadway locations can be seen on the maps (beginning with Figure 4-1). The congested corridors in the Boston region are listed below by direction of travel. A corridor appears on the congested corridors list if the Congestion Management Process indicated that there is a congestion issue in either the AM or PM peak period. Corridors are determined to be congested if any of the following performance measures is below the set threshold: observed travel speed, level of service, or speed index,. Each of these measures is an indicator of an aspect of congestion, and they often overlap in what they are measuring. The CMP has determined the following arterial corridors

within the Boston Region to be congested: the congested arterial and expressway corridors are listed in Table 5-1 and Table 5-2, below.

TABLE 5-1
Congested Arterial Corridors*

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
Fresh Pond Pkwy.	NB	Soldiers Field Rd. on-ramp	Rte. 2	A	V/C (both)
Fresh Pond Pkwy.	SB	Rte. 2	Soldiers Field Rd. on-ramp	A	TS (AM), SI (both), V/C (both)
Rte. 107	NB	Rte. 16	Albert J. Brown Circle	A	TS (PM), SI (PM), V/C (PM), LOS (AM)
Rte. 107	SB	Albert J. Brown Circle	Rte. 16	A	TS (PM), SI (both), V/C (PM), LOS (AM)
Rte. 109	EB	I-495	Birch St.	A	V/C (both)
Rte. 109	WB	Birch St.	I-495	A	V/C (both)
Rte. 114	EB	Palmer Ave.	Marblehead TL	A	TS (both), SI (both), V/C (PM), CR, LOS (both)
Rte. 114	WB	Marblehead TL	Palmer Ave.	A	TS (both), SI (both), V/C (PM), CR, LOS (both)
Rte. 119	NB	Pope Rd.	Rte. 2	A	SI (both)
Rte. 119	SB	Rte. 2	Pope Rd.	A	SI (both)
Rte. 127	EB	Essex TL	Rte.128	A	V/C (both)
Rte. 127	WB	Rte. 128	Essex TL	A	V/C (both)
Rte. 129	EB	Rte. 1A	Ocean Ave.	A	TS (both), SI (both), V/C (both), CR, LOS (both)
Rte. 129	WB	Ocean Ave.	Rte. 1A	A	TS (both), SI (both), V/C (both), CR, LOS (both)
Rte. 138	NB	Park Ave.	I-93	A	TS (AM), SI (both), V/C (both)

*Rte. = Route, A = arterial, PLAR = partially limited-access roadway, LAR = limited-access roadway, TS = travel speed, SI = speed index, V/C = volume/capacity ratio, LOS = level of service, CR = crash rate, TL = town line

(cont.)

TABLE 5-1 (Cont.)
Congested Arterial Corridors

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
Rte. 138	SB	I-93	Park Ave.	A	TS (PM), SI (both), V/C (both)
Rte. 140	NB	Maple St.	Foxborough TL	A	TS (both), SI (both), V/C (both)
Rte. 140	SB	Foxborough TL	Maple St.	A	TS (PM), SI (both), V/C (both)
Rte. 145	EB	Boston TL	Revere TL	A	V/C (AM)
Rte. 145	WB	Revere TL	Boston TL	A	V/C (AM)
Rte. 16	EB	Concord St.	Capital St.	A	TS (both), SI (both), V/C (both)
Rte. 16	WB	Capital St.	Concord St.	A	TS (both), SI (both), V/C (both)
Rte. 1A	NB	Bell Circle	Oak Island Rd.	A	TS (PM), SI (PM), V/C (both), CR, LOS (both)
Rte. 1A	SB	Oak Island Rd.	Bell Circle	A	TS (both), SI (both), V/C (both), CR, LOS (both)
Rte. 1A	SB	Rotary	First Bell Circle signal	A	TS (PM), SI (both)
Rte. 1A	NB	Kingman St.	Market St.	A	SI (AM), LOS (AM)
Rte. 1A	SB	Lynnway stop sign	Kingman St.	A	SI (both)
Rte. 1A	NB	General Edwards Bridge	Hanson St.	A	SI (PM)
Rte. 203	EB	Harvard St.	I-93	A	TS (both), SI (both)
Rte. 203	WB	I-93	Harvard St.	A	TS (both), SI (both)
Rte. 203/ Jamaicaway	EB	Willow Pond Rd.	Forest Hills Rotary	A	SI (PM), LOS (AM)
Rte. 203/ Jamaicaway	WB	Forest Hills Rotary	Willow Pond Rd.	A	TS (AM), SI (both), LOS (AM)

(cont.)

TABLE 5-1 (Cont.)
Congested Arterial Corridors

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
Rte. 27	NB	Depot St.	Canton St.	A	V/C (PM)
Rte. 27	SB	Canton St.	Depot St.	A	V/C (PM)
Rte. 28	NB	Highland Ave.	Assembly Sq. Mall	A	SI (both)
Rte. 28	SB	Assembly Sq. Mall	Highland Ave.	A	SI (both)
Rte. 28	SB	Riverside Ave.	Presidents Landing	A	SI (both)
Rte. 28	NB	Third St.	Twin City Mall	A	None
Rte. 28	SB	Twin City Mall	Third St.	A	SI (both)
Rte. 28	NB	Presidents Dr.	Riverside Ave.	A	TS (AM), SI (both)
Rte. 30	EB	I-90	Rte. 9	A	SI (both), V/C (PM)
Rte. 37	NB	Rte. 139	I-93	A	TS (PM), SI (both), V/C (both)
Rte. 37	SB	I-93	Rte. 139	A	TS (both), SI (both), V/C (both)
Rte. 3A	NB	Hingham TL	I-93 Interchange	A	TS (both), SI (both), LOS (PM), V/C (AM)
Rte. 3A	SB	I-93 Interchange	Hingham TL	A	TS (both), SI (both), LOS (PM), V/C (AM)
Rte. 4	NB	Rte. 2	Billerica TL	A	TS (PM), SI (both), V/C (both), CR
Rte. 4	SB	Billerica TL	Rte. 2	A	TS (both), SI (both), V/C (both), CR
Rte. 60	EB	Newton St.	Trapelo Rd.	A	TS (both), SI (both)
Rte. 60	WB	Trapelo Rd.	Newton St.	A	SI (both)
Rte. 62	EB	Bedford-Concord TL	Burlington TL	A	TS (both), SI (both), V/C (both), LOS (AM)

(cont.)

TABLE 5-1 (Cont.)
Congested Arterial Corridors

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
Rte. 62	WB	Burlington TL	Bedford-Concord TL	A	TS (PM), SI (both), V/C (both), LOS (AM)
Rte. 99	NB	Dexter St.	Shute St.	A	TS (PM), SI (PM), V/C (both)
Rte. 99	SB	Shute St.	Dexter St.	A	TS (both), SI (both), V/C (both)
Mystic Valley Pkwy.	EB	Auburn St.	Main St.	A	TS (AM), SI (both), V/C (both)
Mystic Valley Pkwy.	WB	Main St.	Auburn St.	A	TS (both), SI (both), V/C (both)
Storrow Drive	EB	Memorial Dr.	Leverett Circle	A	TS (AM) , SI (both), V/C (both)
Storrow Drive	WB	Leverett Circle	Memorial Dr.	A	V/C (both)
Rte. 3/Rte. 3A	NB	Country Club Rd.	Billerica TL	A	SI (both), V/C (both)
Rte. 3/Rte. 3A	SB	Billerica TL	Country Club Rd.	A	SI (both), V/C (both)

TABLE 5-2
Congested Corridors: Limited-Access Roadways and Expressways

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
I-90	EB	Oak St. overpass	Centre St.	LAR	TS (both), SI (both), V/C (both)
I-90	EB	Cambridge St. overpass	Toll plaza	LAR	TS (both)
I-90	WB	Centre St.	Weston TL	LAR	TS (both), SI (PM), V/C (AM)
I-90	WB	Toll plaza	Exit 17 (Newton/Watertown)	LAR	TS (both), SI (both)
I-93	NB	Granite Ave.	Government Center	LAR	TS (both), SI (both), V/C (both)
I-93	SB	Government Center	Granite Ave.	LAR	TS (both, SI (PM), V/C (both)
I-93	NB	Leverett Circle	I-95	LAR	TS (PM), SI (PM), V/C (both)
I-93	SB	I-95	Leverett Circle	LAR	TS (AM), SI (AM), V/C (both)
I-93	NB	Massachusetts Ave.	Braintree Split	LAR	TS (both), SI (both), V/C (both)
I-93	SB	Braintree Split	Massachusetts Ave.	LAR	TS (both), SI (PM), V/C (both)
I-93/Rte. 128	NB	I-95	Braintree Split	LAR	TS (both), SI (both), V/C (both)
I-93/Rte. 128	SB	Braintree Split	I-95	LAR	TS (both), SI (both), V/C (both)
I-95	NB	Winter St.	Rte. 3	LAR	TS (PM), SI (PM), V/C (both)
I-95	SB	Rte. 3	Winter St.	LAR	TS (AM), V/C (both)
Rte.128	NB	Braintree Split	Dedham St. overpass	LAR	TS (AM), SI (AM), V/C (both)

(cont.)

TABLE 5-2 (Cont.)
Congested Corridors: Limited-Access Roadways and Expressways

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
Rte.128	SB	Dedham St. overpass	Braintree Split	LAR	V/C (both)
I-95	NB	I-93	Rte. 30	LAR	TS (AM), V/C (both)
I-95	SB	Rte. 30	I-93	LAR	TS (both), SI (PM), V/C (both)
Rte. 1A/Rte. 60	NB	Logan on-ramp	U-turn	PLAR	TS (PM), SI (PM)
Rte. 1A/Rte. 60	SB	U-turn	Logan on-ramp	PLAR	SI (AM)
Rte. 2	NB	Newtown Rd.	I-95/Rte. 128	PLAR	TS (AM), SI (both), V/C (both)
Rte. 2	SB	I-95/Rte. 128	Newtown Rd.	PLAR	TS (PM), SI (both), V/C (both)
Rte. 2	EB	Lake St.	Alewife signal	LAR	SI (both)
Rte. 2	WB	Alewife signal	Lake St.	LAR	SI (both)
Rte. 24	NB	Avon TL	Rte. 139	LAR	TS (both), SI (AM)
Rte. 24	SB	Rte. 139	Avon TL	LAR	None
Rte. 24	NB	Mazzeo Dr.	I-93	LAR	TS (both), SI (AM), V/C (both)
Rte. 24	SB	I-93	Mazzeo Dr.	LAR	TS (PM), SI (PM), V/C (both)
Rte. 3	SB	Braintree Split	Exit 14	LAR	TS (AM), SI (AM), V/C (both)
Rte. 3	NB	Exit 14	Braintree Split	LAR	TS (AM), SI (AM), V/C (both)
Rte. 9	EB	Southborough	Brookline Ave.	PLAR	TS (PM), SI (both),V/C (both), CR, LOS (both)

(cont.)

TABLE 5-2 (Cont.)
Congested Corridors: Limited-Access Roadways and Expressways

Roadway	Direction	From	To	Type of Roadway	Congestion Indicator
Rte. 9	WB	Brookline Ave.	Southborough	PLAR	TS (both), SI (both), V/C (both), CR, LOS (both)
Rte. 1	NB	City Square	Chelsea off-ramp	PLAR	SI (PM)
Rte. 1	SB	Chelsea off-ramp	City Square	PLAR	TS (AM), SI (AM)
Rte. 1	NB	I-93	Route 99 on-ramp	PLAR	SI (PM), V/C (AM)
Rte. 1	SB	Lowell St.	I-93	PLAR	SI (AM), V/C (AM)
Rte. 1/VFW	NB	I-95	Centre St.	PLAR	TS (both), SI (both)
Rte. 1/VFW	SB	Centre St.	I-95	PLAR	TS (both), SI (both)

Congested Interchanges

Listed in Tables 5-3 and 5-4, below, are the most congested interchanges in the Boston Region. The approach speed and speed index were analyzed to determine which intersections were congested. The interchanges are displayed by time of day and direction. The interchange information was collected and analyzed in 2008.

TABLE 5-3
The Ten Most Congested Interchanges in the AM Peak Period

Freeway	Freeway Section	Direction	Interchange	Speed Index	Approach Speed
Route 3 South	Route 14, Duxbury, to I-93, Braintree	NB	Int. 16, Route 18	0.2	12
Route 3 North	New Hampshire state line to I-95/Route 128, Burlington	SB	Int. 30N, Lowell Connector	0.22	12
I-93 North	Int. 31, Route 16/Mystic Valley Parkway	SB	Int. 31, Route 16/Mystic Valley Parkway	0.27	15
I-93 North	I-95/Route 128, Woburn/Reading, to Route 28, Somerville	SB	Int. 30, Route 38/Mystic Avenue	0.27	15
I-93/SE Expressway	Route 3, Braintree, to Southampton Street, Boston	NB	Int. 12, Route 3A/Neponset	0.27	15
I-93/SE Expressway	Route 3, Braintree, to Southampton Street, Boston	NB	Int. 13, Freeport Street	0.27	15
Route 1 North	I-95, Peabody, to I-93, Charlestown	SB	Route 99	0.34	17
I-90	I-495, Hopkinton, to Logan Airport, Boston	WB	Int. 18, 19, & 20, Allston-Brighton	0.35	19
I-93/SE Expressway	Route 3, Braintree, to Southampton Street, Boston	NB	Int. 14, Morrissey Boulevard	0.36	20
Route 24	Route 140, Taunton, to I-93 (Route 128), Randolph	NB	Int. 19, Harrison Boulevard	0.4	26

TABLE 5-4
The Ten Most Congested Interchanges in the PM Peak Period

Freeway	Freeway Section	Direction	Interchange	Speed Index	Approach Speed
I-90	I-495, Hopkinton, to Logan Airport, Boston	WB	Int. 18, 19, & 20, Allston-Brighton	0.18	10
Route 3 North	New Hampshire state line to I-95/Route 128, Burlington	NB	Int. 30N, Lowell Connector	0.22	12
I-93 North	Int. 31, Route 16/Mystic Valley Parkway	NB	Int. 31, Route 16/Mystic Valley Parkway	0.27	15
I-93 North	I-95/Route 128, Woburn/Reading, to Route 28, Somerville	NB	Int. 30, Route 38/Mystic Avenue	0.27	15
Route 1 North	I-95, Peabody, to I-93, Charlestown	NB	Route 99	0.34	17
I-90	I-495, Hopkinton, to Logan Airport, Boston	EB	Int. 18, 19, & 20, Allston-Brighton	0.35	19
Route 1A/Route 60		SB	Porter Street off-ramp	0.38	15
I-95/Route 128	University Avenue, Canton, to Route 9, Wellesley	SB	Int. 13, University Avenue	0.4	22
I-90	I-495, Hopkinton, to Logan Airport, Boston	WB	Int. 17, Newton Corner	0.4	22
I-93/SE Expressway	Route 3, Braintree, to Southampton Street, Boston	SB	Int. 16, Southampton Street	0.44	20

Congested Locations on the Network of HOV Lanes

The location of the worst congestion on Boston's HOV network is the northbound HOV lane (in the evening) on the Southeast Expressway. Travel times have been increasing for both the HOV and general-purpose lanes over the past nine years, since 2002, except at the very beginning and end of each peak period. Congestion in this network reaches its peak at about 8:00 AM. Despite the congestion, the travel time saved by using the HOV lanes is about 8 minutes, which does meet the state's Department of Environmental Protection (DEP) standards for travel time savings. The DEP standards are that the travel time for each mile of HOV travel should be at least one minute less than for one mile of travel in the general-purpose lanes. Another issue is that while the Southeast Expressway's southbound HOV lane did not show significant congestion, it also did not meet the DEP standards.

Public Transit

The following table (Table 5-5) shows data for the 10 bus routes with the lowest percentage of weekday trips meeting the on-time performance threshold: Routes 171, 459, 553, 455,[1] 558, 435, 556, 450, 434, and 429. Any bus route that has fewer than 60% of its trips performing on time does not pass the congestion threshold for on-time performance.

Table 5-6, below, shows the commuter rail lines that failed to meet on-time performance standards. During the first three months of 2011, none of the MBTA commuter rail lines met the on-time performance threshold of 95% of trips operated on time.

Table 5-7, below, shows the congested corridors for the rapid transit lines. Both the Red Line and the Orange Line failed to meet the on-time performance standard. The B Branch of the Green Line and the Mattapan High-Speed Line also failed to meet the standard.

1 MBTA bus route 455 has experienced a reduction of service since the writing of this document.

TABLE 5-5
Top Ten Bus Routes with the Lowest On-Time Performance[2]

Bus Route Name	Bus Route Number	Weekday On-Time Performance*
Dudley Station–Logan Airport Station	171	22%
Salem Depot–Downtown Crossing	459	37%
Roberts–Downtown Boston	553	41%
Salem Depot–Wonderland	455	42%
Riverside–Downtown Boston	558	43%
Liberty Tree Mall–Central Square (Lynn)	435	44%
Waltham Highlands–Downtown Boston	556	46%
Salem Depot–Haymarket/Wonderland Station	450	46%
Peabody–Haymarket	434	46%
Northgate Shopping Center–Central Square (Lynn)	429	46%

Percent of buses running on time (less than 5 minutes late).

TABLE 5-6
Commuter Rail Lines That Failed to Meet On-Time Performance Standards, December 2011, February 2012 and March 2012[3]

Rail Line	Average On-Time Performance
Rockport	85%
Fitchburg	88%
Providence	90%
Newburyport	91%
Stoughton	94%
Haverhill	94%

2 Any bus route that has fewer than 60% of its trips performing on time does not pass the congestion threshold for on-time performance.

3 Any commuter rail line that has fewer than 95% of its trips performing on time does not pass the congestion threshold for on-time performance.

TABLE 5-7
Rapid Transit Lines That Failed to Meet On-Time Performance Standards, December 2011, February 2012, and March 2012[4]

Rail Line	Average On-Time Performance
Orange Line	94.30%
Red Line	94.60%

The MBTA bus routes that fail to meet the Load Standard Adherence during at least one of the three monitoring periods (weekday, Saturday and Sunday) are: bus routes 1, 7, 8, 9, 10, 11, 14, 15, 16, 17, 19, 21, 22, 23, 28, 29, 30, 31, 32, 34, 35, 36, 39, 40, 41, 44, 45, 47, 51, 59, 62, 64, 65, 66, 67, 69, 70, 71, 73, 75, 76, 77, 80, 83, 86, 87, 88, 89, 90, 93, 96, 101, 104, 106, 108, 109, 110, 111, 112, 116, 117, 120, 136, 137, 191, 192, 216, 222, 225, 230, 238, 240, 350, 411, 429, 430, 441, 442, 450, 455, 459, 553, 701, 741, 742, 749, and 751.

According to data used for the preparation of the MBTA's Preliminary 2010 Service Plan, the following rapid transit lines failed to meet passenger load standards: the Blue Line (evening and late evening), the Red Line Braintree branch (midday base), the Red Line trunk service (midday, outside the core area), the Green Line B Branch outside the core area (midday base, evening, and late evening), the Green Line C Branch (outside the core area, evening), and the Green Line D Branch outside the core area (midday base, evening, and late evening). The rapid transit lines that failed to meet the passenger load standards are displayed in Table 5-8.

TABLE 5-8
Rapid Transit Lines That Failed to Meet Passenger Load Standards

Rapid Transit Line	Area	Time of Day
Blue Line	Core	Evening, late evening
Red Line (Braintree)	Non-core	Midday base
Red Line (Trunk)	Non-core	Midday base
Green (B)	Non-core	Midday base, evening, late evening
Green (C)	Non-core	Evening
Green (D)	Non-core	Midday base, evening, late evening

The only commuter rail line with any observed violation of passenger load standards is the Lowell Line during the PM peak period.

[4] Any rapid transit line that has fewer than 95% of its trips performing on time does not pass the congestion threshold for on-time performance.

Park-and-Ride Lots

The park-and-ride lots in Table 5-9 had utilization rates of 90% or more on a typical weekday in 2009–10 and are therefore likely in need of increased capacity.

TABLE 5-9
Park-and-Ride Lots That Failed to Meet Parking Utilization Standards

Station	Line	Lot Ownership	Parking Spaces	Occupied Parking Spaces[5]	% Parking Space Utilization
Ayer	Fitchburg	Town	82	80	98%
Lincoln	Fitchburg	Town	44	43	98%
Littleton	Fitchburg	Town	66	65	98%
South Acton	Fitchburg	Town	385	362	94%
Waltham	Fitchburg	Town	94	88	94%
Greenwood	Haverhill	Private	6	6	100%
North Wilmington	Haverhill	Town	50	49	98%
Reading	Haverhill	On-street	37	37	100%
Wedgemere	Lowell	MBTA	124	124	100%
Wedgemere	Lowell	On-street	31	31	100%
West Medford	Lowell	MBTA	20	19	95%
West Medford	Lowell	Town	45	44	98%
Winchester	Lowell	Town	151	138	91%
Beverly Depot	Newburyport/Rockport	On-street	56	55	98%
Ipswich	Newburyport/Rockport	On-street	22	22	100%
Ipswich	Newburyport/Rockport	Town	128	126	98%
Manchester	Newburyport/Rockport	MBTA	68	66	97%
Salem	Newburyport/Rockport	Town	121	120	99%
Swampscott	Newburyport/Rockport	MBTA	126	119	94%
Swampscott	Newburyport/Rockport	On-street	16	16	100%
Auburndale	Framingham/Worcester	MassDOT	60	55	92%
Wellesley Hills	Framingham/Worcester	On-street	18	17	94%
Wellesley Hills	Framingham/Worcester	Town	51	48	94%
Worcester	Framingham/Worcester	MBTA	115	103	90%
Endicott	Franklin	Town	45	45	100%
Franklin	Franklin	MBTA	118	116	98%
Norwood Central	Franklin	MBTA	68	68	100%
Walpole	Franklin	Private	328	315	96%

(cont.)

5 Occupied parking spaces at time of last AM-peak-period inbound train.

TABLE 5-9 (Cont.)
Park-and-Ride Lots That Failed to Meet the Parking Utilization Standards

Station	Line	Lot Ownership	Parking Spaces	Occupied Parking Spaces[6]	% Parking Space Utilization
Needham Center	Needham	Town	124	118	95%
Needham Junction	Needham	MBTA	171	166	97%
Sharon	Providence/Stoughton	MBTA	37	37	100%
Sharon	Providence/Stoughton	Town	709	635	90%
Wood Island	Blue Line	Private	82	77	94%
Forest Hills	Orange Line	MBTA	202	199	100%
Malden	Orange Line	MBTA	198	192	98%
Oak Grove	Orange Line	MBTA	760	693	100%
Braintree	Red Line	MBTA	981	905	100%
Butler	Red Line	MBTA	44	42	100%
Savin Hill	Red Line	MBTA	20	18	95%
Woburn Bus Yard	MBTA Express Bus	MBTA	75	70	98%
Hingham	Commuter Boat	Private	293	287	91%

Bicycle and Pedestrian Facilities

According to the needs assessment that was conducted for the Boston Region MPO's current Long-Range Transportation Plan, *Paths to a Sustainable Region*, less than 2% of the region's non-interstate roadways provide bicycle accommodations, and half of the region's non-interstate roadways do not have a sidewalk on at least one side.[7] There are a few transit stations that are scattered throughout the MBTA system that have insufficient bicycle capacity and stations that surpassed the bicycle utilization standards, as can be seen in Tables 5-10, 5-11, and 5-12.

[6] Occupied parking spaces = at time of last AM-peak-period inbound train.

[7] Boston Region MPO's Long-Range Transportation Plan, *Paths to a Sustainable Region, Vol. 2,* "Regionwide Needs Assessment."

TABLE 5-10
Rapid Transit Stations That Surpassed the Bicycle Utilization Thresholds

Station	Line	Utilization %
Porter	Red Line	108%
Harvard	Red Line	119%
Haymarket	Orange Line, Green Line	100%
Newton Center	Green Line D Branch	94%

TABLE 5-11
Bus Stations That Surpassed the Bicycle Utilization Thresholds

Station	Route Number	Utilization %
Watertown Square	59, 70, 70A, 71	92%

TABLE 5-12
Commuter Rail Stations That Surpassed the Bicycle Utilization Thresholds

Station	Line	Utilization %
Ipswich	Newburyport/Rockport	100%
Lowell	Lowell	92%
Waltham	Fitchburg Line	88%
Walpole	Franklin Line	100%
Providence	Providence/Stoughton Line	100%

Identification and Assessment of Strategies

Based on monitoring and performance outcomes, CMP staff recommends the funding of certain studies in the UPWP to analyze existing conditions and needs in detail and recommend improvement strategies for implementation. Subsequently, recommendations are considered for funding during development of the MPO's LRTP, TIP, and Clean Air and Mobility Program. For the Boston metropolitan region, appropriate congestion management strategies fall into seven categories.

CONGESTION MANAGEMENT STRATEGIES

- **Travel Demand Management (TDM)** – Encouraging land use and travel patterns that reduce congestion (such as parking management, flexible work hours, carpooling, vanpooling, ridesharing, car sharing, telecommuting, and flexible work schedules).
- **Promote the Use of Nonmotorized Modes** – Focusing on infrastructure improvements to promote the efficiency of bicycling and walking. This category also includes considering principles of livability and "complete streets."[1]
- **Incident Management** – Responding to causes of nonrecurring congestion, such as roadway crashes, special events, bad weather, and certain categories of construction.
- **Intelligent Transportation Systems (ITS) –** Using technology to make the CMP network function more efficiently. Some examples of ITS strategies are signal timing and transit signal prioritization.
- **Traffic Management and Operations** – Operating the system more efficiently with the existing capacity (such as by optimizing traffic signals, metering traffic on freeways, and making geometric improvements).

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[1] "Complete streets" is a design concept for designing or retrofitting roadways for multimodal use to promote quality of life, mobility, and safety for all users.

- **Public Transportation** – Increasing the efficiency, reliability, and mode share of public transportation. The focus is on the modernization of the public transit system.
- **Road Capacity** –Targeted capacity additions such as turning lanes or extended acceleration lanes can increase traffic throughput at an intersection and reduce congestion.

The following section lists, for each category above, potential specific congestion management strategies that may be in the interest of this region to implement. Each strategy is accompanied by a description of the strategy and a discussion of its advantages, disadvantages, and current status, and the performance measures that should be used for evaluating a strategy's effectiveness after the strategy has been implemented.

List of Specific Strategies

Travel Demand Management

Programs to Encourage Ridesharing, Transit Use, Bicycling, and Walking

Description

Programs for encouraging modes of transportation other than single-occupant-vehicle travel, such as ridesharing, transit, bicycling, and walking. These programs usually involve public outreach efforts focused on encouraging a single mode. Methods include providing information to the public (for example, maps and schedules to encourage transit use, and “rules of the road” brochures to encourage legal bicycle use) and, in the case of ridesharing, matching people who have similar commuting patterns so that they can travel together.

Pros

These programs can be effective in reducing single-occupant-vehicle travel. Increasing the number of people who bicycle and walk also has benefits for public health due to the associated increase in daily exercise.

Cons

Some programs, if not effectively planned or managed, may not achieve their goals and may not have a significant impact on commuting patterns.

Status

There are currently several TDM programs in the Boston Region MPO area.

- MassRIDES (www.commute.com) operates a statewide travel-options program that encourages people to carpool, vanpool, telecommute, use public transit, bike, and walk, and assists them in changing their travel patterns. MassRIDES also provides consultation to companies that analyze worksite conditions and map workers’ home locations and travel patterns to see where there are opportunities for expanding on-site travel demand programs.
- MassBike (www.massbike.org) and other advocacy groups promote bicycling as a means of transportation in the region.
- WalkBoston (www.walkboston.org) is a nonprofit organization dedicated to improving the walking environment in the Boston region.
- The MBTA (www.mbta.com) has many resources for facilitating transit use, such as smartphone apps (software applications) that provide traveler information.

- Transportation Management Areas (TMAs), with the main objective of influencing transportation policies, creating programs and encouraging the use of alternative modes of transportation.[2] Examples of TMAs that operate within the MPO area include the ABC TMA in downtown Boston, the Charles River TMA in Cambridge, the Seaport TMA in the South Boston Waterfront, TransCom at BU Medical Center, and Commute Works at MASCO.
- Safe Routes to School is a program that improves the health and mobility of children and their parents by promoting alternative travel modes. There are several Safe Routes to School projects in the federal fiscal years (FFYs) 2012–15 TIP.

Evaluation Metrics

Mode shares (percent of commuters walking, bicycling, using transit, or ridesharing)

Programs that Encourage Flextime, Telecommuting, Staggered Work Hours, and Remote Work Centers

Description

Alterations of employees' work hours and/or locations so that an employee does not have to commute during peak periods. These strategies would move some peak-period work trips into the off-peak period. Telecommuting eliminates some work trips altogether. Remote work centers can shorten a worker's commute by having the worker commute to the work center closer to home rather than to an office that is farther from home.

Pros

These programs would eliminate demand on the roadways and therefore have an impact on peak-period congestion.

Cons

There no cons with these strategies. In this MPO region, they are important for employers to implement with the assistance of MassRIDES.

Status

The Transportation Management Associations work together to implement and promote these strategies.

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[2] MassRides, Employers-TMA, available online at http://www.commute.com/employers/tma (accessed October 26, 2011).

Evaluation Metrics

The metrics used are the percent of commuters who enroll in programs that implement flextime, telecommuting, and staggered work hours and that have access to remote workstations.

Improving Infrastructure for Nonmotorized Modes

Pedestrian and Bicycle Infrastructure Improvements – "Complete Streets"

Description

Improvements to pedestrian and bicycle infrastructure can help to encourage a higher proportion of people to walk or bike for their transportation needs, thus reducing automobile congestion.

Improvements to pedestrian infrastructure may include:

- Installing new sidewalks where none previously existed
- Repairing or widening existing sidewalks
- Removing obstacles, such as improperly placed street furniture or utility infrastructure, from sidewalks
- Installing pedestrian signals or improvements to existing signals (for example, optimizing signal timing to reduce jaywalking rates, or replacing antiquated signals with modern pedestrian countdown signals)
- Installing new, improved, or repainted crosswalks and associated signs
- Constructing sidewalk buffer areas (to provide some distance between pedestrians and cars)
- Reducing speed limits and increasing the use of traffic calming measures

Improvements to bicycle infrastructure may include

- Adding bicycle lanes
- Creating shared-use paths (also beneficial to pedestrians)
- Installing bicycle parking amenities

"Complete Streets" Programs:

- Requiring new roadway projects to accommodate users of all travel modes
- Implementing "road diets" – reducing the number of travel lanes and/or the effective width of lanes

Pros

Improvements in the quality of life.

Cons

There are no cons for “complete streets,” although many may feel differently due to fiscal reasons. “Complete streets” concepts deal with roadway design improvements for all users in roadway design and should be implemented where feasible.

Status

The Boston region has a complex and varied network of pedestrian and bicycle facilities. An assessment of current facilities and needs for improvement is available in the MPO’s Long-Range Transportation Plan, *Paths to a Sustainable Region*.[3] A “complete streets” approach (www.completestreets.org), already being implemented in parts of the Boston region, is designed to provide safe access to all users, including pedestrians, bicyclists, motorists, and transit riders.[4]

Evaluation Metrics

Mode shares (percent of commuters walking or bicycling to work), number and rate of crashes that involve pedestrians or bicyclists.

Incident Management

Traffic Incident

Description

Surveillance, response, and clearance of traffic incidents, including developing and managing plans for the diversion of traffic from roads affected by the incident.

Pros

Having a well-defined and well-managed multidisciplinary incident management program to respond to incidents can alleviate congestion and prevent secondary crashes or incidents.

Cons

Funding must be secured.

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[3] The Boston Region MPO’s Long-Range Transportation Plan, *Paths to a Sustainable Region,* September 22, 2012.

[4] For information on “complete streets,” see www.completestreets.org.

Status

Massachusetts State Police, MassDOT, all MPO transportation agencies, and municipal police and fire departments participate in existing programs.

Evaluation Metrics

Detection time, response time, clearance time, hours of congestion, and person-hours of delay related to incidents.

Improved Response to Weather and Road Surface Problems

Description

Improved, faster response to road problems caused by weather (for example, snowfall) and to road surface problems such as potholes.

Pros

Makes roads safer (for example, by reducing crashes) and reduces congestion related to road problems.

Cons

Funding must be secured.

Status

MassDOT, police and fire departments, and utility services have response programs.

Evaluation Metrics

Pavement conditions, case-by-case reporting.

Intelligent Transportation Systems

Real-Time Traffic Monitoring and Management Systems (including incident management and work zone management)

Description

Intelligent transportation systems that monitor traffic remotely and respond to traffic patterns, events, and incidents by adjusting factors such as utilizing signal-timing and variable-message signs.

Pros

A technological solution with high potential for reducing congestion by adjusting traffic flows.

Cons

Regionwide traffic monitoring requires cooperation among multiple jurisdictions, which can be a challenge.

Status

Several traffic monitoring and management systems are in place in the Boston region, and interagency communication is in need of improvement.

Evaluation Metrics

Travel speed, speed index, delay, traffic volume, volume-to-capacity ratio, level of service, hours of congestion, and number of incident-related crashes.

Integration of the Payment System for Tolls, Park-and-Ride Lots, and Transit

Description

This strategy involves integrating the payment methods for transit fares, parking fees at park-and-ride lots, and roadway tolls into a single system, so that users of the transportation system could pay all of these fees with a single electronic card or other device, similar to the CharlieCard system currently in operation for MBTA rapid transit and bus service.

Pros

Facilitates travel, especially intermodal travel (for example, car-to-train commuting) by making payment faster and easier.

Cons

Would require the implementation of a regionwide payment system; much cooperation among agencies would be required, and the cost would be substantial.

Status

Not yet implemented.

Evaluation Metrics

The metric used is the mode share (for transit), park-and-ride lot utilization, toll revenues.

Provide and Market Regionwide Real-Time Information on Travel Conditions, Alternate Routes, and Alternate Modes

Description

Through various avenues, real-time travel information would be provided to travelers using all modes; outreach would be conducted to ensure that the information reaches as many people as possible. Avenues may include variable message signs, audible announcements, mobile phone apps, and Internet applications.

Pros

Has the potential to make travel more efficient for many people by assisting with travel planning, including planning alternative routes; likely to reduce congestion.

Cons

If the effort to provide real-time information is concentrated in high-tech avenues such as smartphone apps, lower-income and less technologically inclined populations may not benefit.

Status

Real-time information is already available—for example, MassDOT’s 511 system and variable message signs are operated on major roadways.

Evaluation Metrics

Hours of congestion, travel speed, and person-hours of delay before and after the implementation of a regionwide comprehensive traveler information system.

Optimization of Traffic Signal Timing

Description

Modify traffic signal timing so that traffic flows as smoothly as possible. Typically applied on a corridor basis (along an arterial).

Pros

Reduces delay at traffic signals. May reduce the number of crashes.

Cons

May increase delay at cross streets due to longer green lights on the main corridor. May increase delay for pedestrians trying to cross the main corridor.

Status

There are proposals to study signal timing at several locations throughout the region on a corridor basis.

Evaluation Metrics

Level of service, intersection delay, crash rate.

Traffic Management and Operations

Reversible Commuter Lanes and Movable Median Barriers for Arterials or Highways

Description

A strategy for increasing capacity on a roadway in one direction by borrowing underutilized capacity from travel lanes that normally go in the opposite direction. Typically, a lane that is normally outbound is rededicated to inbound traffic during the AM peak period; a lane that is normally inbound is rededicated to outbound traffic in the PM peak period. This may be accomplished by traffic signals (a large red X indicates that a lane is closed to approaching traffic, while a green arrow indicates the lane is open) or by movable median barriers.

Pros

May reduce congestion and improve travel times. Requires less space than adding two permanent lanes.

Cons

Reversible commuter lanes without median barriers may present a safety hazard in some cases (for example, if motorists do not notice the traffic signals).

Status

A reversible HOV lane, separated by a movable median barrier, is in operation on I-93 south of downtown Boston.

Evaluation Metrics

Travel speed, speed index, delay, traffic volume, volume-to-capacity ratio, hours of congestion.

Access Management

Description

A set of techniques to control access to roadways. May include access spacing (increasing the distance between access points, including driveways on non-limited-access roads), separated turning lanes, and median treatments.

Pros

Reduces congestion and travel times. Improves safety. These strategies often relieve a bottleneck without the need of roadway expansion.

Cons

Relatively expensive. On commercial arterials, removal of access driveways may be met with opposition by business owners.

Status

Currently being implemented by MassDOT and communities as part of project implementation.

Evaluation Metrics

Travel speed, speed index, delay, traffic volume, volume-to-capacity ratio, hours of congestion, level of service.

HOV Lanes

Description

Lanes restricted to vehicles occupied by two or more persons and motorcyclists.

Pros

May improve road capacity by reducing the total number of vehicles on the road. Benefits ridesharing commuters by allowing them to bypass congested single-occupant-vehicle traffic.

Cons

Generally expensive. Requires concerted enforcement efforts to discourage violations. Will require either extra space for new lanes or the conversion of existing lanes to HOV lanes.

Status

Currently, the only HOV lanes in the region are on I-93 and I-90. However, there is a possibility of adding new HOV lanes in the future.

Evaluation Metrics

Travel speed, speed index, delay, traffic volume, volume-to-capacity ratio, hours of congestion, vehicle occupancy (number of persons per vehicle).

Geometric Improvements to Roads and Intersections

Description

Modifications to roads and intersections, such as restriping of paint lines, modification of signage, improvement of sight lines, and traffic-calming measures.

Pros

Reduces crashes, can reduce congestion, and can make roads and intersections friendlier to all users.

Cons

Impacts on congestion can vary.

Status

Many current TIP projects involve geometric improvements to roads and intersections.

Evaluation Metrics

Level of service, intersection delay, crash rate.

Public Transportation

Adjust Transit Schedule by Time of Day

Description

This strategy can shift capacity to a different time of day, which would reduce the frequency of service during off-peak times and provide more frequent service during the peak when passenger loads are higher.

Pros

Minimal cost, and can fix passenger load problems for many transit lines.

Cons

Not generally effective on transit lines where the passenger loads are excessive throughout the day. This could cause the quality of service to drop during off-peak hours.

Status

The MBTA is constantly adjusting the schedules of all of its transit lines.

Evaluation Metrics

Passenger load factor.

Increase Transit Frequency and Span

Description

Increase the frequency with which transit vehicles run and the span (the number of hours throughout each day) that transit service operates.

Pros

Reduces wait time for transit, making it a more attractive option for people who would otherwise drive; therefore reduces traffic congestion. Also alleviates crowding on transit vehicles.

Cons

Requires additional funding, if new equipment is required.

Status

Current focus is on maintenance and modernization.

Evaluation Metrics

Change in transit route frequency; change in transit route span; change in transit ridership, passenger load factor.

Transit Signal Prioritization

Description

A system in which transit vehicles on a shared roadway (buses and sometimes light rail trolleys, such as the Green Line) have the ability to send electronic requests to a traffic management system that can extend the green phase of a signal cycle, or make a traffic signal turn green sooner than it otherwise would, as the transit vehicle approaches.

Pros

Has the potential to improve transit vehicle efficiency and travel speeds.

Cons

May cause traffic congestion on cross streets along a transit corridor— something to watch for and avoid implementing strategy in those cases.

Status

Transit signal prioritization is used for Silver Line buses on the SL1 and SL2 routes and is also considered for other roads where MBTA buses operate.

Evaluation Metrics

On-time performance of transit vehicles, the number of crashes involving transit vehicles.

Bus Rapid Transit

Description

Provides service similar to bus service, but with a variety of modifications to traditional bus transit that improve speed and efficiency, approaching the service quality of rail transit. Methods include signal prioritization, expedited fare collection, stop consolidation, and separate busways that eliminate competition from other traffic modes.

Pros

Increases the efficiency of bus transit. Marketing efforts may make BRT attractive to populations who would otherwise only want to use rail transit, not bus transit.

Cons

May sometimes require additional right-of-way for infrastructure. There may be challenges in establishing coordination between municipalities for the implementation of features such as signal prioritization.

Status

The MBTA's Silver Line routes (SL1, SL2, SL4, and SL5) are considered a form of BRT.

Evaluation Metrics

On-time performance of transit vehicles, seating capacity.

Provide Transit Users with Real-Time Transit Arrival Information

Description

Facilitates travel by making transit use easier and more efficient for users. Examples: Many rapid transit systems provide transit arrival times on variable message screens at platforms or via applications for mobile devices. A pilot program in San Francisco has extended this technology to predict bus arrivals at certain bus stops (variable message signs are powered by solar power).

Pros

Encourages more people to use transit; makes it more convenient; may reduce roadway congestion.

Cons

Accuracy is important; therefore, systems that predict transit arrival inaccurately may reduce the credibility of the transit provider and lead the public to consider the system a waste of resources.

Status

On the bus system, Silver Line 4 and 5 buses have real-time variable-message signs. There are also variable-message signs for buses at Ruggles, Back Bay, and Bellingham Square in Chelsea, and there are plans to install them at the Dudley and Forest Hills stations. For heavy rail, variable-message signs were recently installed at South Station, and there are plans to install variable-message signs on the rest of the heavy rail system by the end of 2012. The MBTA has partnered with Next Bus to provide AVL data available for smartphones.

Evaluation Metrics

Transit mode share.

Provisions for Bicycles at Transit Stops and on Transit Vehicles

Description

Bicycles take up a relatively small amount of space, but provide the opportunity to travel much faster than on foot. Therefore, the linking of bicycle use to transit use has a great deal of potential to improve travel efficiency for many users of the system. The two main strategies involved are providing bicycle parking at transit stations (typically facilitating bike-transit-walk trips) and allowing bicycles on transit vehicles (typically facilitating bike-transit-bike trips).

Pros

Encourages transit use and bicycle use for those inclined to use transit and bikes; may provide a convenient option for a large number of commuters.

Cons

Loading bicycles onto the front bike racks on buses may cause delays at bus stops and negatively affect on-time performance. Bikes on trains may cause an obstruction and a safety hazard, if the transit operator has not made specific accommodations for them.

Status

There are several provisions for linking bicycle and transit use in the MBTA system:

- "Pedal & Park" facilities, which are enclosed, access-controlled, and video-monitored bicycle parking, had been installed, as of May 2012, at two rapid transit stations (Alewife and Forest Hills). The Pedal & Park facilities are in various stages of procurement and construction and will be completed incrementally between the fall of 2011 and the summer of 2012. The MBTA has installed 16 of the planned 50 BikePorts (covered bike shelters) at subway and commuter rail stations, and had planned to complete the remainder by the spring of 2012.
- Non-enclosed bike racks are available at most train stations. Some stations have covered parking.
- Bike racks are mounted on more than 70% of MBTA buses, covering 72 bus routes.[5]
- Outside of peak commuting hours, bikes can be taken on heavy rail trains (the Blue, Red, and Orange lines) and on commuter trains.
- Folding bikes are allowed on all trains at all times.
- Currently, non-folding bikes cannot be carried on light rail vehicles in the MBTA system (the Green Line and Mattapan High-Speed Line). Some transit systems (for example, the TRIMET system in Portland, Oregon) provide hooks for hanging bikes on the inside of designated light rail vehicles.[6]

Evaluation Metrics

On-time performance of transit vehicles, transit mode share, bicycle mode share, number of linked bicycle-transit trips.

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[5] MBTA, "Bikes and the T," available on the MBTA's website, www.mbta.com (accessed June 6, 2012)

[6] TRIMET, "How to Load Your Bike on MAX," http://trimet.org/howtoride/bikes/bikesonmax.htm (accessed July 28, 2011).

Improvements to Bicycle and Pedestrian Routes that Lead to Transit Stops

Description

Focus investments on bicycle and pedestrian infrastructure on routes that lead to transit stops, in order to encourage more bike-transit and walk-transit linked trips.

Pros

Increases multimodal travel.

Cons

Such investments are fairly expensive if constructing new bike paths would be required.

Status

Many TIP projects include bicycle and pedestrian improvements around transit stations.

Evaluation Metrics

Number of linked trips combining transit with biking or walking,[7] overall increase in transit ridership.

Infrastructure Modernization

Description

Updating signal equipment and other transportation infrastructure to increase the efficiency of the transit network.

Pros

May have a significant impact on on-time performance.

Cons

Can be expensive, with some projects costing over $100 million. May sometimes be a temporary solution rather than a permanent one, depending on the situation. For example, repairing railway ties, ballasts, and rail line can be a short-term solution versus replacing the railway entirely.

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[7] Number of linked trips is measured by composite impedance from the transportation model. Common factors are considered for each trip, including travel time, travel distance, and cost per trip. This analysis is done by Traffic Analysis Zone.

Status

There are several projects in the region that are implementing this strategy, including many references in the Boston Region MPO's Fiscal Year 2013–16 TIP. This includes plans to modernize the commuter rail and subway right-of-way, the modernization of railyards where railway cars are repaired, the renovation of Blue Line stations to make six-car train service possible, and improvements to the Government Center, Copley and Arlington Green Line stations.[8]

Evaluation Metrics

On-time performance.

Solicitation of Private Operators to Provide Shuttle Bus Service to Transit Stations

Description

Implement this service in areas that are determined to have a market for shuttle bus ridership. Employers or transportation management associations can be solicited to introduce a for-profit or nonprofit bus service to shuttle commuters to a transit stop. This strategy is recommended for operation by a private company because the MBTA is currently focusing on efficiency and maintenance, not service expansion.

Pros

Will provide transit service to commuters that otherwise might not receive it. Minimal cost to local governments, as this service would be run and paid for by private entities.

Cons

Privatized services' prices and quality can depend on the private entities' interests. This strategy would also be dependent on companies' assuming responsibility for implementing and running the new service.

Status

There are several employers and transportation management associations that already offer this type of service in the Boston metropolitan area.

Evaluation Metrics

Shuttle ridership.

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[8] Boston Region Metropolitan Planning Organization, Transportation Improvement Program and Air Quality Conformity Determination: Federal Fiscal Years 2013–2016, Transit Element (accessed October 26, 2012).

Expansion of Roadway Capacity

Description

Adding lanes, or building new roads, to increase capacity.

Pros

May reduce congestion.

Cons

May have impacts on land takings or the environment.

Status

Several expansion projects are currently underway in the Boston region.

Evaluation Metrics

Travel speed, speed index, delay, traffic volume, volume-to-capacity ratio, hours of congestion.

Range of Strategies for Addressing Example Problems

Table 6-1 was developed in order to provide some examples of types of congestion, mobility, and safety problems and indicate how they could be addressed by applying one or more of the identified strategies above.

TABLE 6-1
Congestion, Mobility, and Safety Problems and Potential Strategies

Problem	Strategy
Congested limited-access or partially limited-access roadways	Reversible commuter lanes and movable median barriers
	New HOV lanes
	Expansion, when no other solution is possible
	Real-time traffic monitoring and management systems (including incident management and work zone management)
	Provide and market real-time information on travel conditions, alternate routes, and alternate modes
Congested interchanges	Real-time traffic monitoring and management systems
	Geometric improvements
	Provide and market real-time information on travel conditions, alternate routes, and alternate modes
	Optimization of traffic signal timing
	Courtesy patrol programs
Congested arterials	Access management
	Optimization of traffic signal timing
	Provide and market real-time information on travel conditions, alternate routes, and alternate modes
	Geometric improvements to roads and intersections
Congested intersections	Optimization of traffic signal timing
	Geometric improvements to roads and intersections
	Provide and market real-time information on travel conditions, alternate routes, and alternate modes

(cont.)

TABLE 6-1 (Cont.)
Congestion, Mobility, and Safety Problems and Potential Strategies

Problem	Strategy
Decreasing travel time savings in HOV lanes	HOV lane expansion
	Change the occupancy requirements of the HOV lanes
Low vehicle occupancies	Programs to encourage ridesharing, transit use, bicycling, and walking
Congestion at toll booth approaches	Integration of the payment system for tolls, park-and-ride lots, and transit
	Provide and market real-time information on travel conditions, alternate routes, and alternate modes
Congestion approaching a transit station	Integration of the payment system for tolls, park-and-ride lots, and transit
	Provisions for bicycles at transit stops and on transit vehicles
	Improvements to bicycle and pedestrian routes that lead to transit stops
Transit routes with high levels of passenger crowding	Increase transit frequency and span, and improve on-time performance
Transit routes with poor on-time performance	Transit signal prioritization, modernization of infrastructure
	Integration of the payment system for tolls, park-and-ride lots, and transit
	Improve accessibility to the transportation system for individuals with disabilities
	Bus rapid transit
Park-and-ride lots that fill before the last peak-period transit vehicle leaves	Provisions for bicycles at transit stops and on transit vehicles
	Improvements to bicycle and pedestrian routes that lead to transit stops

(cont.)

TABLE 6-1 (Cont.)
Congestion, Mobility, and Safety Problems and Potential Strategies

Problem	**Strategy**
Park-and-ride lots that fill before the last peak-period transit vehicle leaves *(cont.)*	Implementation of suburban shuttle buses
	Expansion of parking areas
High crash rates	Geometric improvements to roads and intersections
	Optimization of traffic signal timing
	Real-time traffic monitoring and management systems
	Weather-related diversion plans

Programming and Implementation of Strategies

PROGRAMMING OF STRATEGIES

CMP strategies are implemented through the following methods:

- The CMP helps to generate studies for the Unified Planning Work Program (UPWP). For example, expressway and arterial bottleneck locations and congested corridors identified in the CMP data collection process have been selected to be the subjects of UPWP studies. Also, studies dealing with safety and operations at selected intersections are defined by applying criteria, including safety and congestion, to the entire list of intersections in the region in order to develop location priorities for detailed analysis.
- Recommendations from UPWP studies generated by the CMP are considered in project evaluations in the Long-Range Transportation Plan (LRTP) and the Transportation Improvement Program (TIP), in which improvements are recommended for funding. For example, GIS (Geographic Information Systems) analysis is conducted to identify which TIP projects contain CMP priority intersections, and this factor is included in the TIP prioritization process.
- CMP data are the primary source for the LRTP's needs assessment section. Specifically, freeway and arterial needs assessments are identified based on ranges of observed speeds and ranges of speed indexes developed by the CMP.

The congested corridors listed in Tables 7-1 and 7-2 have previously been studied by CTPS staff. Tables 7-3 and 7-4 (below) show the recommended strategies, which are based on a sample of past studies that, when implemented, could help relieve congestion for these corridors. The checklist displays the seven possible types of strategies that could be considered for each corridor. An X indicates that a strategy has already been studied.

The corridors displayed in Tables 7-3 and 7-4 have not been previously analyzed by MPO staff. Therefore, a quick analysis was conducted to see which of the seven strategies might be suitable for relieving congestion within those corridors. This was a preliminary analysis, and the suitable strategies may be subject to change depending on corridor conditions.

Table 7-1
Congestion Management Strategies Previously Analyzed for Congested Corridors: Arterial Roadways

Corridor	Direction	From	To	TDM	Non-motorized	Incident Response*	ITS	Operations	Transit	Expansion
Alewife Brook Pkwy.	NB	Soldiers Field Rd. on-ramp	Route 2	X			X	X	X	X
Alewife Brook Pkwy.	SB	Route 2	Soldiers Field Rd. on-ramp	X			X	X	X	X
Route 107	NB	Route 16	Albert J. Brown Circle	X	X		X	X		
Route 107	SB	Albert J. Brown Circle	Route 16	X	X		X	X		
Route 114	EB	Palmer Ave.	Marblehead TL	X	X		X	X		
Route 114	WB	Marblehead TL	Palmer Ave.	X	X		X	X		
Route 129	EB	Route 1A	Ocean Ave.	X	X		X	X	X	
Route 129	WB	Ocean Ave.	Route 1A	X	X		X	X	X	
Route 1A	NB	Bell Circle	Oak Island Rd.	X	X		X	X		
Route 1A	SB	Oak Island Rd.	Bell Circle	X	X		X	X		
Route 1A	SB	Rotary	1st Bell Circle signal	X	X		X	X		
Route 28	NB	Highland Ave.	Assembly Sq. Mall	X	X			X		
Route 28	SB	Assembly Sq. Mall	Highland Ave.	X	X			X		
Route 3A	NB	Hingham TL	I-93 Interchange	X	X		X	X		
Route 3A	SB	I-93 Interchange	Hingham TL	X	X		X	X		
Route 60	EB	Newton St.	Trapelo Rd.	X			X	X		
Route 60	WB	Trapelo Rd.	Newton St.	X			X	X		
Route 3/3A	NB	Country Club Rd.	Billerica TL	X			X	X		X
Route 3/3A	SB	Billerica TL	Country Club Rd.	X			X	X		X

*Incident responses were not addressed for these corridors as of February 2012.

(cont.)

TABLE 7-1 (Cont.)
Congestion Management Strategies Previously Analyzed for Congested Corridors: Arterial Roadways

Corridor	Direction	From	To	TDM	Non-motorized	Incident Response*	ITS	Operations	Transit	Expansion
Route 138	NB	Park Ave.	I-93	X	X		X	X		X
Route 138	SB	I-93	Park Ave.	X	X		X	X		X
Route 4	NB	Route 2	Billerica TL	X	X		X	X		
Route 4	SB	Billerica TL	Route 2	X	X		X	X		
Route 109	EB	I-495	Birch St.	X			X	X	X	
Route 109	WB	Birch St.	I-495	X			X	X	X	

*Incident responses were not addressed for these corridors as of February 2012.

TABLE 7-2
Congestion Management Strategies Previously Analyzed for Congested Corridors: Limited-Access Roadways and Expressway

Corridor	Direction	From	To	TDM	Non-motorized	Incident Response*	ITS	Operations	Transit	Expansion
I-90	EB	Market St. overpass	Center St.	X	X		X	X		
I-90	WB	Center St.	Weston Border	X	X		X	X		X
I-93	SB	Braintree Split	Government Center	X			X	X		
I-93	NB	I-95	Braintree Split	X				X		X
I-93	SB	Braintree Split	I-95	X				X		X
I-95	NB	Winter St.	Route 3	X				X		X
I-95	NB	I-93	Route 30	X				X		
I-95	SB	Route 30	I-93	X				X		
Route 2	NB	Newtown Rd.	I-95	X			X	X		X
Route 2	SB	I-95	Newtown Rd.	X			X	X		X
Route 24	NB	Mazzeo Dr.	I-93	X					X	
Route 24	SB	I-93	Mazzeo Dr.	X					X	
Route 3	SB	Braintree Split	Exit 14	X			X	X		X
Route 3	NB	Exit 14	Braintree Split	X				X		X
Route 9	EB	Southborough	Brookline Ave.	X	X		X	X		X
Route 9	WB	Brookline Ave.	Southborough	X	X		X	X		X
Route 1/VFW Pkwy	NB	I-95	Centre St.	X	X		X	X	X	X
Route 1/VFW Pkwy	SB	Centre St.	I-95	X	X		X	X	X	X
I-95	NB	I-95/I-93 Split	Dedham St. overpass	X			X	X		
I-95	SB	Dedham St. overpass	Braintree Split	X			X	X		

*Incident responses were not addressed for these corridors as of October 2012.

TABLE 7-3
Possible Solutions for Congested Corridors: Arterial Roadways

Corridor	Direction	From	To	TDM	Non-motorized	Incident Response	ITS	Operations	Transit	Expansion
Route 119	NB	Pope Rd.	Route 2	X				X		
Route 119	SB	Route 2	Pope Rd.	X				X		
Route 127	EB	Essex TL	Route 128	X	X		X	X		
Route 127	WB	Route 128	Essex TL	X	X		X	X		
Route 140	NB	Maple St.	Foxborough TL	X	X		X	X		
Route 140	SB	Foxborough TL	Maple St.	X	X		X	X		
Route 145	EB	Boston TL	Revere TL	X	X	X	X	X		
Route 145	WB	Revere TL	Boston TL	X	X	X	X	X		
Route 16	EB	Concord St.	Capital St.	X	X		X	X		
Route 16	WB	Capital St.	Concord St.	X	X		X	X		
Route 1A	NB	Kingman St.	Market St.	X			X	X		
Route 1A	SB	Lynnway stop sign	Kingman St.	X			X	X		
Route 1A	NB	First signal	Hanson St.	X	X		X	X		
Route 203	EB	Harvard St.	I-93	X	X		X	X		
Route 203	WB	I-93	Harvard St.	X	X		X	X		
Route 203/ Jamaicaway	EB	Willow Pond Rd.	Forest Hills Rotary	X	X		X	X		
Route 203/ Jamaicaway	WB	Forest Hills Rotary	Willow Pond Rd.	X	X		X	X		

(cont.)

TABLE 7-3 (Cont.)
Possible Solutions for Congested Corridors: Arterial Roadways

Corridor	Direction	From	To	TDM	Non-motorized	Incident Response	ITS	Operations	Transit	Expansion
Route 27	NB	Depot St.	Canton St.	X			X	X		
Route 27	SB	Canton St.	Depot St.	X			X	X		
Route 28	NB	Presidents Dr.	Riverside Ave.	X	X		X	X		
Route 28	SB	Riverside Ave.	Presidents Dr.	X	X		X	X		
Route 28	NB	Third St.	Twin City Mall	X	X		X	X		
Route 28	SB	Twin City Mall	Third St.	X	X		X	X		
Route 30	EB	I-90	Route 9	X	X		X	X		
Route 37	NB	Route 139	I-93	X			X	X		
Route 37	SB	I-93	Route 139	X			X	X		
Route 62	EB	Bedford-Concord TL	Burlington TL	X				X		
Route 62	WB	Burlington TL	Bedford-Concord TL	X				X		
Route 99	NB	Dexter St.	Shute St.	X	X		X	X		
Route 99	SB	Shute St.	Dexter St.	X	X		X	X		
Memorial Dr.	EB	Soldiers Field Rd.	Longfellow Bridge	X			X	X		
Memorial Dr.	WB	Longfellow Bridge	Soldiers Field Rd.	X			X	X		
Mystic Valley Pkwy.	EB	Auburn St.	Main St.	X				X		
Mystic Valley Pkwy.	WB	Main St.	Auburn St.	X				X		
Storrow Dr.	EB	Memorial Dr.	Leverett Circle	X				X		
Storrow Dr.	WB	Leverett Circle	Memorial Dr.	X				X		

TABLE 7-4
Possible Solutions for Congested Corridors: Limited-Access Roadways and Expressways

Corridor	Direction	From	To	TDM	Non-motorized*	Incident Response*	ITS	Operations	Transit	Expansion
I-90	EB	Cambridge St. Overpass	Toll plaza	X			X	X		
I-90	WB	Toll plaza	Exit 17 (Newton/Watertown)	X			X	X		
I-93	NB	Leverett Circle	I-95	X				X		
I-93	SB	I-95	Leverett Circle	X				X		
I-93	NB	Government Center	Braintree Split	X			X	X		
I-95	SB	Route 3	Winter St.	X				X		X
Route 1A/ Route 60	NB	Logan on-ramp	U-turn	X				X		
Route 1A/ Route 60	SB	U-Turn	Logan on-ramp	X				X		
Route 2	EB	Lake St.	Alewife signal	X			X	X		
Route 2	WB	Alewife signal	Lake St.	X			X	X		
Route 1	NB	City Square	Chelsea off-ramp	X				X		
Route 1	SB	Chelsea off-ramp	City Square	X				X		
Route 1	NB	I-93	Route 99 on-ramp	X			X	X		
Route 1	SB	Lowell St.	I-93	X			X	X		
Storrow Dr.	WB	Leverett Circle	Memorial Dr.	X				X		

*Nonmotorized responses and incident responses were not addressed for these corridors as of October 2012.

STRATEGY IMPLEMENTATION

Currently, the Boston Region MPO has no dedicated funding for the design and construction of recommendations that result from CMP-recommended studies funded through the UPWP. Instead, many elements of the CMP-defined UPWP studies have been implemented or progressed to design and construction by implementing agencies that have that authority. Typically, recommendations are of the management and operations type for arterial corridors, intersections, and freeway bottlenecks, many of them multimodal according to MassDOT's highway design manual, including principles of "complete streets" and livability. Short-term recommendations are often implemented through municipal or agency maintenance funds. Long-term recommendations are considered by implementing agencies for design and construction according to their priorities and in combination with other considerations.

A good way to promote the implementation of CMP recommendations is to "educate" the stakeholders, the decision makers, and members of the public about this process. The basis of the implementation of the Boston Region MPO's Congestion Management Process is the newly-formed CMP Committee in which stakeholders and staff have begun to collaborate and critique each other's recommendations about what solutions are best for the region. Once a consensus is reached, it will be easier to advocate for these projects to decision makers in the MPO and across the region.

In 2012, the Boston Region MPO Congestion Management Committee was formed. It consists of the following MPO members:

- MassDOT
- Massport (Chair)
- Regional Transportation Advisory Council (RTAC)
- City of Boston
- City of Everett
- City of Woburn

Evaluation of Strategy Effectiveness

According to federal guidance on the development of the CMP, once CMP-recommended strategies are implemented through TIP funding, before-and-after studies are performed to measure strategy effectiveness. However, as discussed in the previous section about Programming, the Boston Region MPO's CMP largely informs study selection in the UPWP and contributes in the evaluation of needs assessment in the LRTP and the evaluation of recommended projects in the LRTP and the TIP. As other factors, including those based on other visions and policies of the MPO, are considered in project implementation, there is no steady stream of projects that are implemented as a result of direct CMP input. Therefore, there is currently no account of CMP-recommended projects that have been implemented to evaluate.

Instead, in FFY 2012, CMP staff requested and received UPWP funding to evaluate implemented recommendations from two projects that were constructed by 2008–2009, very similar to those typically recommended in a CMP-generated UPWP study: largely dealing with safety and operations improvements at arterial intersections. Two projects selected for before-and-after studies are listed in Table 8-1, below.

TABLE 8-1
Projects Selected for Before-and-After Studies

Projects Selected for Before-and-After Studies	**Description**
Arlington – Roadway Reconstruction on a Section of Route 2A (Summer Street)	The work consists of reconstructing the roadway, constructing cement concrete sidewalks, installing granite curbing, and upgrading the existing drainage.
Westwood – Reconstruction, Route 109 (High Street) from Grove Street to Hartford Street (8,780 feet)	This project proposes to reconstruct High Street utilizing full-depth reconstruction. Included are sidewalks, walls, drainage, curbing, signs, and pavement markings. New traffic signals will be installed at Hartford Street, Gay Street, Windsor Road/Public Library Entrance, and Summer Street. The project will accommodate bicycles and be fully accessible to persons with disabilities. Extensive landscaping and site furnishings are also included.

The evaluation was performed according to the following criteria:

- Crashes
- Level of service
- Traffic volume

“Before”/”After” evaluation revealed that crash rates dropped in all cases and level of service improved in the overwhelming majority of the AM and PM conditions that were examined for four intersections.

The conclusions from evaluation were that the following safety and congestion measures were effective, when implemented at the four locations:

- Signal head visibility
- Proper timing and phasing design of traffic signal
- Additional left-turn lanes
- Accommodation of pedestrians

These findings lead to the overall conclusion that safety and operations-type of improvements are effective in reducing crashes and operational efficiencies at arterial locations. These types of improvements are advocated in federal CMP guidance as being part of the strategy collection termed Management and Operations (M & O), and they are highly recommended for their ability to achieve operational efficiencies, often at low cost.